ENGINEERING NEWS-RECORD

NOVEMBER 29, 1945

Discharge of 10,000 cfs. of water through energy dissipator at Fontana Dam on Little Tennessee River

Featured In This Issue

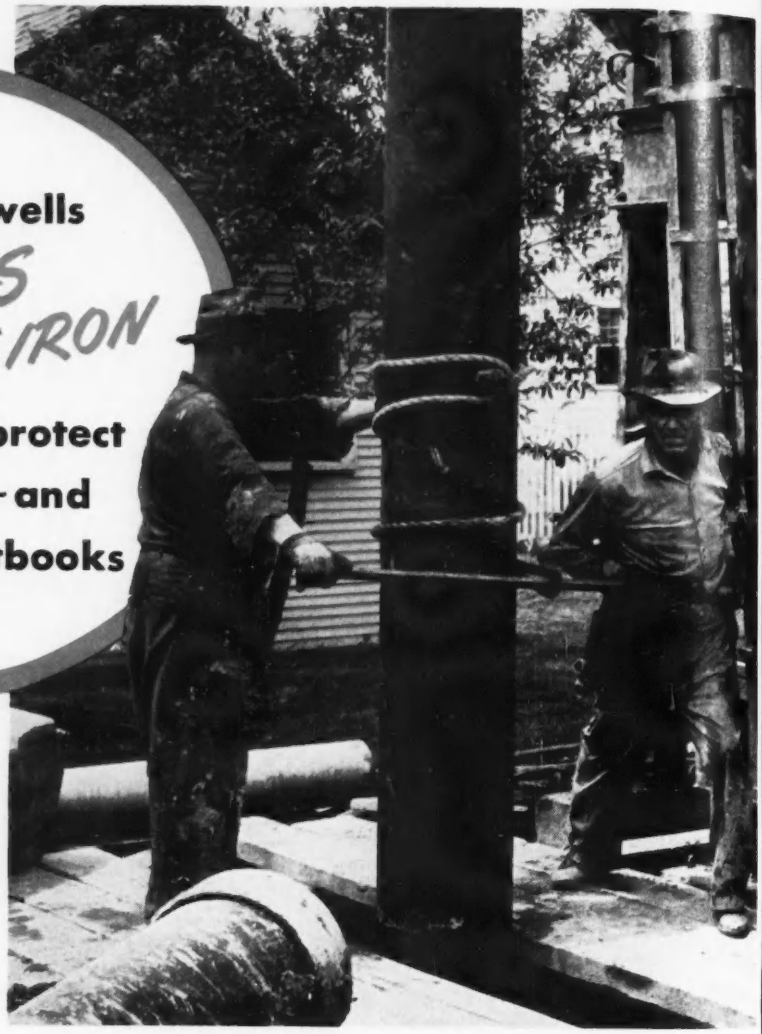
DESIGN FOR NEW TACOMA NARROWS BRIDGE

ARMY HOSPITALS OF SHEET STEEL • HOW TO DRIVE TIMBER PILES

In 12 new wells

BYERS WROUGHT IRON

helps protect public health — and public pocketbooks



When the City of Lansing, Michigan, recently sunk twelve new wells, the Board of Water and Electric Light Commissioners took careful steps to protect the purity of the water, and the permanence of the installations. Byers genuine wrought iron drive pipe, 14-inches OD and with a ⅜-inch wall, was used in all twelve. Layne Northern Company was the driller.

Well piping is likely to be subjected to corrosion both from within and without, and even small perforations may permit pollution from surface drainage. Where this affects the purity or potability of the water, the only cures are expensive replacements, or a new well.

Byers Wrought Iron has made some impressive records in well service, under extremely severe conditions. The superintendent of the water department in one middlewest municipality wrote that when a 52-year-old well was enlarged, the original wrought iron casing was found to be in excellent condition. Another stated that the wrought iron casing in an old well served without any leakage for 43 years, and only a few small holes had developed after 52 years, when a larger well was drilled. On the sea coast, where casing is exposed to salt marsh mud, one user reported that no trouble had ever been experienced with the 40-year-old wrought iron casings.

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Byers Wrought Iron pipe for wells is available right now, in any quantity and for any project. If you would like further information on the application of wrought iron in any specific service, our Engineering Service Department will be glad to give it to you. Just write.

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ENGINEERING NEWS-RECORD

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WALDO G. BOWMAN, *Editor* ALBERT E. PAXTON, *Publisher*

Vol. 135 NOVEMBER 29, 1945 No. 22

COMING NEXT

• In less than three years nearly $2-billion was spent for plants and equipment, living facilities for construction and operating personnel, and for research that was necessary for the creation of the atomic bomb. Construction for this project was probably the largest and most rapid coordinated building job ever undertaken.

• With special permission of the U. S. War Department, *ENR* will devote its entire issue of December 13 to a series of articles describing the various phases of construction and design problems incident to this unprecedented project. These articles will cover nearly every branch of civil engineering—from surveying through structural design, foundations, water and sewerage facilities, city planning, housing, etc.

• The articles in this issue will comprise the first authentic account of the construction required for production of the atomic bomb—an issue that will unfold an engineering and construction story of uncommon scope and interest.

LOOKING AHEAD

• The Hawkesbury River in New South Wales, Australia, long known for its deep, soft-mud bottom and consequent foundation-building difficulties, has again been spanned—this time by a bridge in which one pier is more than 240 ft. deep. The two main spans are entirely shop welded trusses of 438-ft. length, said to be the longest trusses in the world built by this method. Foundation problems and construction procedure will be described in an early issue.

• Recording ocean currents by radio with a new type meter is proving both feasible and accurate in surveys now being conducted in Alaskan and Aleutian waters. The instrument and method of use will be discussed in a forthcoming issue.

• Precast concrete forms, eliminating the use of steel shapes, were set deep underwater to confine tremie placed concrete for walls and floors on three graving docks at San Francisco. Gantries spanning the work handled the precast forms and supported the tremie pipes. They also carried circular saws for uniform underwater cutting of foundation piles. The tremie placing method used resulted in subaqueous concrete equal in quality to that poured in the dry. The project will be discussed in an early issue.

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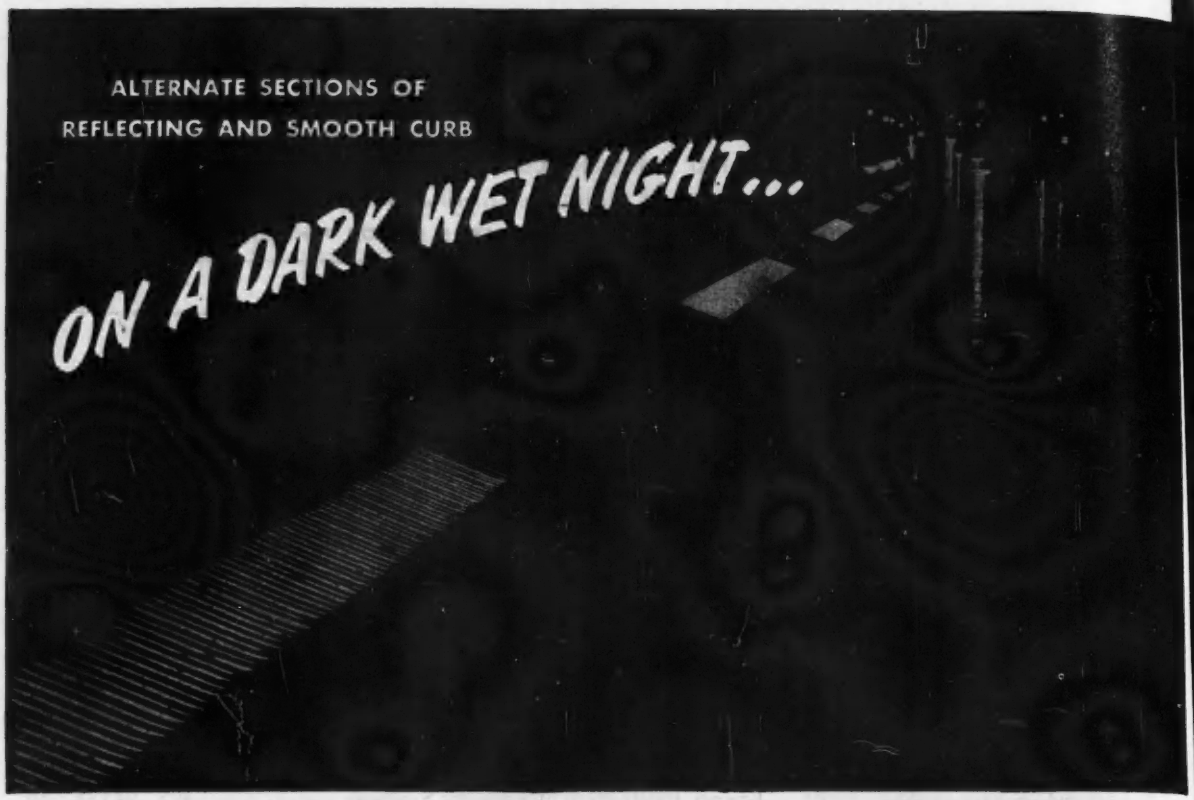
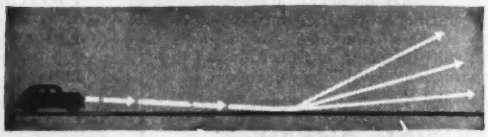


White Concrete Reflecting Curb reduces driving danger!

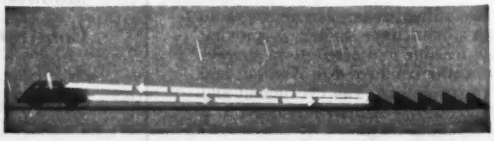
Reflecting curb is at its best on dark rainy nights. For the saw-tooth faces catch headlamp rays and reflect them brightly back to the driver.

A rainy night generally reduces the visibility of a smooth curb (see black sections above). Headlight rays, on such a wet, mirror-like surface, skid more completely away from the driver. This makes the smooth curb practically invisible. On the other hand, a corrugated reflecting curb, made of identical white materials and under identical conditions provides an even brighter reflecting surface. Thus the rain that reduces the visibility of a smooth curb makes a reflecting curb more visible.

You can build this extra-factor-of-safety into any road—old or new! It clearly defines the road's edge . . . guides the driver safely and comfortably . . . reduces danger to a minimum! Write for full details.



A smooth curb (above) wastes the car's headlights. It reflects them away from the driver. A White Concrete Reflecting Curb (below) conserves this light. It reflects the headlights back to the driver. Thus a smooth curb is barely visible at night, while a White Concrete Reflecting Curb stands out—bright and clear. Write for details.



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The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • NOVEMBER 29, 1945 • VOLUME 135 • NUMBER 22

House group approves fund for reclamation, planning

Appropriations committee also recommends funds for PRA but turns down large requests for Army Engineer projects, veterans housing and hospitals

An appropriation sufficiently large to permit the Bureau of Reclamation to start a major construction program was approved Monday by the House Committee on Appropriations in reporting out the First Deficiency Appropriation Bill for 1946.

The committee also recommended that the Bureau of Community Facilities of the Federal Works Agency be supplied with additional funds to aid local public works planning, and an appropriation of $25,000,000 for the Public Roads Administration to match early expenditures of state highway departments.

Denied, however, were large requests for funds for constructing veterans housing, an extensive hospital program of the Veterans Administration, numerous Army Engineers rivers and harbors projects, and early work planned by the International Boundary Commission.

The Bureau of Reclamation got the largest appropriation for construction, as the bill was reported out. This agency is provided with a total of $77,205,000—$22,000,000 less than the amount originally requested. The bill provides $42,765,000 for the general construction fund, this including the following amounts: Davis Dam, $5,000,000; Central Valley, $19,215,000; Colorado-Big Thompson, $5,000,000; and Columbia Basin, $10,050,000.

The Committee recommended a total of $20,442,000 for construction under the bureau's special reclamation fund.

Other appropriations recommended for the bureau include: $3,000,000 for the All-American Canal and $480,000 for the Fort Peck Project. This latter item is intended to be used for the construction of the Fort Peck-Williston Transmission line to provide power for construction on the Missouri River of Garrison Dam.

The bureau was also provided $10,269,100 for work on the Missouri River Basin. Construction of Kortes, Angostura and Boysen Dams can be started with this money.

Although President Truman had requested $50,000,000 for the Bureau of Community Facilities to aid local public works planning groups, the committee favored an additional appropriation of only $12,500,000 for this work.

The group said that planning groups as of Oct. 30 had been obtaining about $2,500,000 monthly and they saw no reason for an appreciable increase in the funds available.

The committee refused the request of the Corps of Engineers for $128,475,000 for construction, planning and a small amount of maintenance.

In failing to supply the Engineers with money, the committee stated that a number of the projects should have further investigation, particularly those which contemplate starting construction on multi-purpose dams entailing ultimate separate costs of as much as $130,000,000. The committee recommended that the army's entire request be placed before the War Department sub-committee for reconsideration early in January, when hearings will begin on the War Department Civil Functions Appropriation Bill.

In turning down requests for $158 million for continuing construction of veterans' hospitals and new construction, the committee mentioned the limited supply of some building materials and pointed out that many Army and Navy hospitals built to serve war needs are available.

Although the Budget had favored an appropriation of $24,500,000 for temporary housing for veterans, the committee failed to include money for this work. It had been contemplated to tear down in panels 25,000 temporary dwelling units and to supply 20,000 units in "packaged form" to communities willing to pay all expenses pertaining to transportation, preparation of the new building site, and reerection costs. The remaining 5,000 units were to be supplied to those communities unable to bear any part of the expense.

Idaho protests Springston Dam plan

Moving ahead on a major flood control plan for the Spokane River Basin and an extensive development program for a large area of northern Idaho, Seattle District Army Engineers have met with strong opposition to their plan for building Springston Dam.

Statements in opposition to the proposed $36,000,000 earth-and-rock-fill dam on the Coeur d'Alene River have been frequent during the last two months from residents in the area whose mining industry last year produced metals valued at $35,000,000.

Planned for flood control in the Spokane Valley, the dam also would benefit navigation, lumbering, logging, and irrigation, and would eliminate pollution of lake water in the area, it is claimed.

Crest of the dam would be about 2,700 ft. long and about 130 ft. above the valley floor. Maximum normal pool elevation of 2,250 ft. would cover an area of 31,000 acres with storage capacity of 2,800,000 acre ft. The reservoir would back up water for 34 mi. Actual dam construction would cost $18,000,000, while the rest is spent for land, highway and railway relocation.

Strongest objections have been raised by the mining interests, spokesmen for which have claimed their industry would lose tailing dumps, be forced to move major operational facilities, be faced with possible flooding of lower levels in some mines, and lose deep wells from which they obtain cold water for purification of zinc and other smelter operations.

Other protests were based on the fact that Coeur d'Alene River waters would be stored at the dam, where power generation would not be economical, as reserve power for Bonneville Dam in Oregon, outside of Idaho's borders.

NEWS IN BRIEF

In telegraphic form, here are latest news developments on the engineering and construction front during the week.

Construction—Two *California* gas companies applied to the State Railroad Commission for approval on construction of a $12,140,000 pipeline, to stretch 214 miles from Blythe to Santa Fe Springs. . . . Hiram Walker Co., at *Peoria, Ill.*, planned a new $3,000,000 plant. . . . The Duke Power Co. announced it would build a $4,500,000 plant at *Cliffside, N. C.* . . . *Morristown, Tenn.*, will be site of a new $1,500,000 nylon thread plant. . . . Bond Stores, Inc., plans a $1,000,000 building in downtown *Cleveland, Ohio*. . . . The Pere Marquette Hotel, *Peoria, Ill.*, will add 200 rooms to its present structure. . . . A $5,000,000 addition is planned to the Kimberly-Clark Corp.'s paper mill at *Niagara, Wis.* . . . *Philadelphia, Pa.*, plans a $4,500,000 wholesale produce market. . . . Tennessee-Eastman Corp., said it will spend $5,000,000 on its *Kingsport, Tenn.*, plant.

Water Supply—The state legislature authorized *St. Petersburg, Fla.*, to operate sewer and water facilities jointly, combining funds received therefrom. . . . *Cincinnati, Ohio*, considered a recommendation for $7,087,510 in waterworks improvements. . . . *Phoenix, Ariz.*, considered expansion of its water facilities, after receiving reports that supply available in the Verde River is adequate. . . . *Olympia, Wash.*, retained engineers to prepare plans for developing additional supply sources. . . . *Montreal, Canada*, will spend $1,470,539 to repair its McTavish Reservoir.

Highways—*Missouri* will spend $9,000,000 per year for three years on farm-to-market roads. . . . *Wisconsin* said its $43,693,504 road program would be ready for action by spring of 1946. . . . *Illinois* announced it had gathered 1,200 snowplows, 50,000 tons of cinders, 1,500 barrels of snow-melting chemicals, in preparation for the winter. . . .*Oklahoma* received bids on $1,100,608 of new highway projects.

Miscellany—*Kansas City, Mo.*, had a $270,774.85 check on hand to pay for right-of-way for a levee and floodwall to protect the downtown district. . . . In *Philadelphia, Pa.*, plans were pushed to spend $4,000,000 to clear a plaza north of Independence Square. . . . *Montgomery, Ala.*, will spend $2,500,000 on immediate construction of a new hospital, other facilities. . . . The *University of Florida* will build a $750,000 gymnasium. . . . The Hydro Electric Power Commission of Ontario, Canada, has authorized construction of a $7,000,000 power plant on the Madawaska River, near the town of *Arnprior*. . . . Under a new *Massachusetts* law, plans for new buildings will require only approval of local authorities, not of the state Department of Public Safety.

Reject N. Y. housing project bids

The New York City Housing Authority last week announced it had rejected all bids submitted on its Elliott Housing Project, and in order to prevent further delay in construction, would take new bids on foundations only about Dec. 12.

Taking of new bids will mark the third attempt by the authority to get this project under way (*ENR* Nov. 22, vol. p. 685). On the first attempt, Oct. 29, contractors refused to submit bids in protest against a "no labor trouble" clause in the contract as offered. This clause was eliminated, and bids were obtained but the lowest tender was said by the authority to be 68 percent above 1940 costs.

Army Engineers replace 150 miles of trackage

The U. S. Army Engineers, who built and maintained 4,200 miles of railroads and marshalling yards in the U. S. during the war, are replacing 150 miles of trackage at storage depots and permanent installations with standard, medium weight rail. All track which had been laid with sub-standard, mismatched rail and shorts in 50 and 60-lb. weights will be replaced with 75-lb. standard steel already owned by the Army and declared excess.

The installation of new rail, purchased and earmarked for use in the European Theater of Operations before V-E day, will take care of virtually all rail replacements for the Army for the next five years. To date, more than half of the project has been completed.

Net cost has been considerably reduced through the use of surplus stockpiles of ties, bolts, spikes, joint-bars, and tie-plates. All replaced rail is being sold as scrap steel.

The work, under the direction of the Repairs & Utilities Division, OCE, is part of routine maintenance of the Corps of Engineers. No new funds or appropriations will be required.

Name new assistant to Chief of Engineers

Brig. Gen. R. C. Crawford transferred to new post; Maj. Gen. Lewis A. Pick returns as Missouri River Division engineer

Lt. Gen. R. A. Wheeler, Chief of Engineers, has announced the transfer of Brig. Gen. R. C. Crawford, division engineer for the Missouri River Division at Omaha, to Washington as an assistant to the Chief of Engineers.

Successor to Gen. Crawford at Omaha is Maj. Gen. Lewis A. Pick, who returns to the Missouri River engineer office after two years overseas duty. The change will be effected about Dec. 1.

General Crawford has served as division engineer at Omaha since December, 1943, during which time a $1.5 billion military construction program was completed in the 10-state area. General Crawford has also served as chairman of the Missouri Basin Inter-Agency Committee, and he is a member of the Board of Engineers for Rivers and Harbors. He was assigned to Omaha from Ft. Belvoir, Va., where he was commandant of the Engineer School from June, 1940, to Nov., 1943.

General Pick, who commanded the advanced section, Army Service Forces, India-Burma Theater, from October, 1943, to September of this year, returns to the post of division engineer at Omaha which he occupied from April, 1942, to September, 1943.

Principal features of his report on control and development of water resources in the Missouri basin were later incorporated in the comprehensive basin development plan approved by Congress in the Flood Control Act of December, 1944. Pick is a native Virginian and was graduated from the Virginia Polytechnic Institute in 1914 with a reserve engineer commission. He served in the Philippine Islands, in the district engineer's office in New Orleans, as instructor at the Command and General Staff School, Ft. Leavenworth, and in the Ohio and the Missouri River divisions.

General Crawford was born in Bridgewater, Pa., and was graduated from the U. S. Military Academy, West Point, in 1912. He was an instructor at the Engineer School from 1919 to 1922, and was assistant district engineer at Seattle, Wash. From 1932 to 1936, he was district engineer at Detroit, Mich., and was district engineer at Honolulu until July, 1937, when he returned to the U. S. as assistant to the South Pacific Division Engineer in San Francisco. He assumed command of a battalion of the 5th Engineers at Ft. Belvoir in 1938 and became commanding officer of the regiment in 1939.

New York City plans ready for start of $285 million highway program

Report lists many projects available for 1946 start—Almost all are express highway or parkway developments

New York City has plans virtually complete and financing arranged for a $285,000,000 arterial highway and parkway program covering the next five years, Robert Moses, Park Commissioner and Chairman of the Triboro Bridge Authority, reported this week.

Projects that will cost about $100,000,000 are scheduled to start within the first three years, and three more in 1949-50. In addition, a $7,000,000 southerly extension of the Bronx River Parkway, will be built during 1946-47 as an entirely state-financed project.

Extent of the projects—aimed at improving motor access to New York and its surrounding manufacturing and residential areas—is shown on the accompanying map. Existing routes are shown as heavy black lines, with proposed new routes shown as broken lines.

The entire program is to be financed jointly by the federal, state and city governments. Under this financing scheme, the city's total share of the overall cost would be about $170,000,000. Of this total, the city plans to finance $37,054,125 by issuance of long-term bonds, and $132,939,748 by borough and local property assessments.

The largest single item on the bond-financed program is a $10,913,000 project to construct approaches and connections to the Brooklyn-Battery tunnel in lower Manhattan, most of the work being scheduled for start in 1946.

Construction to be financed by assessment will include work valued at $46,597,645 during 1946, most of this sum to be spent for improvement of the belt parkway system circling Brooklyn and Queens.

Breakdown by boroughs

A breakdown of items listed in Mr. Moses' report by boroughs includes:

Brooklyn: Brooklyn-Queens Expressway (those sections not included in the federal-state program)—$16,675,722. Bronx: Construction of Bruckner Boulevard, link between Bronx end of the Triborough Bridge and the proposed New England Thruway (see map). Manhattan: West Side Elevated Highway extension south to Battery Park, $1,443,195; East River and Harlem River drives, $30,000,000. Queens-Midtown Expressway, $10,000,000.

The New England Thruway project in the northeast Bronx will connect the city's various expressways with Westchester County parkways and highways leading towards Boston. Other roads not included in the above listing are: A Cross-Bronx Expressway to link George Washington Bridge traffic with Bronx parkway systems; the Van Wyck Expressway to serve Idlewild Airport (now under construction), the Bronx River and Deegan expressways.

Mexico's road program goes ahead steadily

Mexico will be able to complete her 1945 road building and reconstruction program since ample funds for the undertaking are now available and the handicap of lack of sufficient machinery is fast being overcome, according to the Ministry of Communications and Public Works.

Northwestern University to build $2 million hotel

A $2,000,000 apartment hotel, the largest housing unit in Evanston, Ill., will be erected by Northwestern University to provide accomodations for its faculty and students, including returned veterans, according to Harry L. Wells, vice president and business manager.

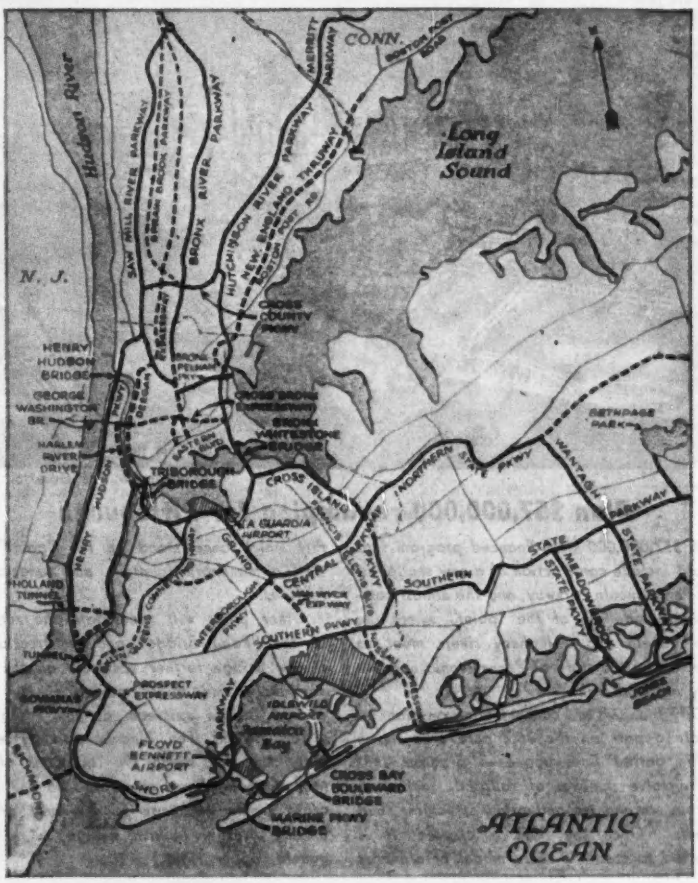
The new building will consist of 7 stories and basement, and will contain a minimum of 208 apartments of 1, 2, 3, 4, and 5 rooms. All apartments will be unfurnished.

The basement will contain a garage to accommodate 126 cars. The front of the first floor will consist of apartments; the rear will be divided into service rooms, a kitchen, and a dining room seating 240 persons.

Approximately $2,000,000 of Northwestern's funds will be invested in the building. It will be operated by the university and rented on a "reasonable" basis to its faculty, students, and the public.

According to present plans the building will be completed by Jan. 1, 1947.

The architects are Holabird and Root. The contractor will be Raymond C. Wieboldt Co.



Reclamation group meets at Denver

Several hundred members of the National Reclamation Association met at Denver, Colo., last week to hear talks on the reclamation picture by Harry W. Bashore, Reclamation Commissioner, Lt. Gen. R. A. Wheeler, Chief of Engineers, and others.

At the close of their session, members approved a series of resolutions which: Opposed formation of regional authorities such as the proposed Missouri Valley Authority; urged forestation studies; urged increase of federal power rates to remove more of the cost of multiple-purpose projects from water users; and urged Congress to approve funds for resumption of war-interrupted construction.

Outstanding among the resolutions ultimately passed by the group, and one which brought the most heated argument from the floor, was disapproval of the statutory 160-acre limit for farms using water furnished by Bureau of Reclamation irrigation projects. However, general opinion of the final resolution was that it was worthless because of too weak and ambiguous wording. The resolution to be presented to Congress, as adopted by the delegates, says: "Customs of land use and occupation have developed, and vested rights have attached through ownership and use" practices which make it "difficult and uneconomical to conform to limitations."

During arguments from the convention floor, J. E. Sturock of Austin, Tex., told delegates "the limitation is a socialistic doctrine that stinks to high heaven," while Roland Curran of Bakersfield, Calif., charged that "starry-eyed social economists dominate the policies of the reclamation bureau."

Rebuttal to the anti-land limit campaign came from Secretary Harold L. Ickes through a message read by Ora Bundy, of Ogden, Utah, president of the association. Ickes pointed out that "more and more the vast corporation farm is displacing the family farm," and that this "dangerous tendency" could lead to "American peasantry."

All present officers of the association were reelected.

Pittsburgh Post-Gazette photo

Plan $57,000,000 revamping for Pittsburgh

A $57,000,000 state-financed program that would include construction of a new section of the Penn-Lincoln Parkway, and the almost complete remodelling of the "point" where the Monogahela and Allegheny rivers meet, is planned by the state of Pennsylvania and the City of Pittsburgh.

City planners are concentrating on plans to create a park on the 36.2 acre area shown within dotted lines above—a program that will involve removal of railroad tracks, numerous warehouses and other structures, and streets. Once the land is cleared, it is planned to create a scale model of old Fort Pitt which once stood on the "point", install a mammoth fountain, and landscaping features.

Other plans will necessitate the removal of the "Point Bridge" and construction of a new bridge further upstream on the Monongahela, and actual moving of the Manchester Bridge upstream on the Allegheny.

The 9.3 mi. Penn-Lincoln parkway would enter the city along the left bank of the Monongahela shown at right, with one elaborate traffic exchange to be built at the Liberty Bridge, (fourth bridge on Monongahela, upper right.)

General Stratton heads Army civil works

Succeeds retiring Col. G. R. Goethals in post—New appointee formerly special aid to Chief of Engineers

Brig. Gen. James H. Stratton has been named as director of the Civil Works Division, Office of Chief of Engineers, by Lt. Gen. Raymond A. Wheeler, who was recently made chief of the U. S. Army Engineers (*ENR* Sept. 13, vol. p. 337). General Stratton succeeds Col. George R. Goethals, who plans to retire.

General Stratton has had a varied assignment with the U. S. Army Engineers. Following graduation from West Point, the Engineer School at Camp Humphreys, and Rensselaer Polytechnic Institute, he served in the Canal Zone with the 11th Engineers. Upon return to the United States in 1927 he was assigned to the 104th Engineers, New Jersey National Guard, and four years later to Fort McIntosh, Texas, for duty with the 8th Engineers.

From October 1933 to August 1935 General Stratton served in the St. Paul Engineer District, later in Tucumcari, N. M., Engineer District, and subsequently as chief of the Conchas, N. M., Engineer District. In May 1937 he was transferred to Boston as chief of the engineering division in that office. His next assignments were at Denison, Texas, at Conchas Dam again, and at the Caddoa, Colo., Engineer District. In December 1941 General Stratton was ordered to Washington, D. C. as chief of the engineering branch, Construction Division, Office of the Chief of Engineers, and in November 1943, he was named chief of operations, headquarters, Services of Supply, in the European Theater of Operations. General Stratton returned to the U. S. in April 1945 as special assistant to the Chief of Engineers.

Colonel Goethals is the son of Maj. Gen. George W. Goethals, of Panama Canal fame. Upon graduation from the Military Academy in 1908 he spent nearly six years in the Canal Zone and then served at various stations until World War 1, when, as a lieutenant colonel, he went over with the American Expeditionary Force as engineer officer on the staff of the Chief of Artillery, First Army. He retired in 1919 but was recalled to active duty in 1940 to be district engineer at Buffalo, becoming director of the civil works program in 1942.

During his retirement, Colonel Goethals served first as a consulting engineer in New York City, and subsequently as assistant construction manager, Dwight P. Robinson and Co.

Latin nations plan more construction

The variety of engineering work coming to the fore "south of the border" was indicated last week as Latin-American nations continued to report plans (see also *ENR* Nov. 22, vol. p. 687).

The work—on which U. S. engineers are expected to take a heavy part—included dredging work in Ecuador, and extensive construction work for Honduras.

The Province of Guayas, Ecuador, has requested the American Embassy at Quito to furnish information on U. S. engineers and contractors interested in carrying out surveys for a $4,356,000 dredging project on the Babahoyo River.

The embassy reported to Washington last week that a special committee, known as the Comite Ejecutivo de Viakidad, will oversee the work. The group is said to be interested in contacting a firm that will handle financing, engineering and construction. The proposal is to dredge the Babahoyo River to the mouth of the Yaguachi, to dredge the Daule River above the city of Daule, and to build a canal from the Yaguachi to the Babahoyo.

Firms interested in the work were asked to contact Joseph F. Burt, American consul general at Quito.

Work in Honduras

The recently-incorporated Choluteca Honduras Development Co., whose United States office is in Portland, Ore., holds a contract with the Republic of Honduras to plan and construct fruit canneries, hydro-electric projects, sawmills and transportation facilities in that country, C. A. Hall, company president, has announced in Portland.

Canning of pineapples and other fruit, together with exportation of mahogany, will constitute the main business of the firm, Hall said, but the company also holds the following engineering and construction contracts:

Electric generating plants and transmission lines for San Marcos de Colon, Choluteca; and for Lanque, San Lorrenzo and Nacoome, the latter three in departmento Valle.

Cutting and milling 1,200,000 bd. ft. of pine lumber for Gral. J. Inez Perez, San Marcos de Colon, Honduras.

Development of hydro-electric power and construction of transmission lines in Southern Honduras, surveys for which will be made next year.

Engineers of the firm will leave soon for Honduras to set up headquarters on Amapala island in Southern Honduras.

At Bogota, Columbia, a government announcement said that Congressmen Alberto A. Tavera, and Gregoria M. Luiz—both civil engineers—will spend three months in the United States studying modern road building methods and equipment at the invitation of the Office of Inter American Affairs.

Pan-American congress of engineers planned

A Pan-American engineering congress—the first attempted—will be held sometime next year, Dean S. S. Steinberg of the University of Maryland College of Engineering has announced.

Just back from an 18,000-mile, 3½-month plane trip to 12 Latin American countries, he said the congress will bring together engineers and engineering professors of the Americas for an interchange of ideas. The date and place of meeting are not yet decided.

Dean Steinberg was sent on the tour by the State Department to survey engineering in South America and to arrange for future exchange of engineering professors, students and literature. Currently, he is preparing a report to the State Department.

Los Angeles water consumption shattered all records in one day last summer when in the 24-hour period 486,000,000 gal. were delivered, the equivalent of 286 gals. for each of the city's 1,700,000 residents.

Puerto Rico road work expected to start soon

Puerto Rico will invest $7,046,390 in the development of its highway program for the current fiscal year, it was decided after a visit to the island of a United State Federal Works Agency commission.

The group studied plans and specifications prepared by engineers of the Department of the Interior in San Juan, and discussed details before making a report to the Federal Works Agency. The insular government will provide $4,072,390 and the federal government $3,076,000 for this program. It is expected that the works will start within a few months.

U. S.—Insular contributions

Federal contribution is divided among the following projects: Principal highways, $1,110,000; secondary highways $1,132,000; urban grade crossings, $834,000.

The program calls for a total investment of insular and federal funds amounting to $20,000,000 during the following three years, of which the federal government will contribute $9,000,000. The Department of the Interior in San Juan is now making a selection of the public works to be included in the new program.

Commission members included: H. E. Hilts, deputy highway commissioner; J. Barnett, chief of the urban highway division; W. Simonson, urban project engineer, and F. H. Horton, federal highway engineer.

Tucumcari project water due in spring

Water will be turned into the first unit of the Tucumcari, N. M., irrigation project next spring, Orville I. Craft, acting regional director of Region 5 for the Bureau of Reclamation, has announced. Until recently, it was planned to turn the water into the canal system early in November. (*ENR* Aug. 23, vol. p. 217).

Craft said postponement was decided upon because farmers "do not need moisture at the present time, and because of advances in construction which would be possible if water were not delivered at this time."

About 7000 acres are included in the first unit, now scheduled to receive water next spring. Total acreage in the $5,655,000 project is about 45,000.

Major unit of the project is the 75-mi. long Conchas Canal, designed to carry water from Conchas reservoir to project lands. Five tunnels, with a combined length of almost six miles, were bored through the mountains. In addition, 33 siphons, with a total length of over 12,500 ft., have been constructed.

The project is unusual in that one of the tunnels passes directly underneath the city of Tucumcari. This was done to avoid reducing property values in a select residential section of Tucumcari.

Bids totalling more than half a million dollars for additional work on the project were opened recently. Clyde W. Wood, Inc., Los Angeles, submitted the low bid of $285,865.20 for excavation work for the Conchas and Hudson canals. A. S. Horner Construction Co., Denver, submitted the low bid, of $252,934, for construction of three siphons. The bids must be approved by Harry W. Bashore, Reclamation Bureau Commissioner, before contracts are awarded.

Chicago accepts low bid on large sewer contract

Improvement of sewage collection facilities for 27 square miles of Chicago's South Side District moved toward reality on Nov. 21 when the Santitary District of Chicago awarded a contract for the first unit of its $28,000,000 postwar sewer program. The contract, covering construction of 23,700 lin. ft. of reinforced concrete sewer, was awarded to S. A. Healy Co., Chicago, on their low bid of $10,386,125. Construction will get underway by the middle of December.

The Sanitary District officials did not make public the relation of their engineers' preliminary estimates to the low bid. The second low bid, by Paschen Contractors of Chicago, was $10,906,600.

The new sewer will be 18 ft. wide by 20 ft. high (internal dmensions) and will extend from Pershing Road to Garfield Blvd., passing under the Union Stock Yards. It will be constructed in tunnel.

Known as the South Side intercepting sewer, the new system will divert from the present inadequate Lake Front interceptor all of the drainage from 19 sq. mi. The entire project includes 70,500 ft. of sewer, 13 ft. or more in width and height, and the enlargement of the present Racine Ave. pumping station to more than double its present capacity.

It is expected that four years will be required to complete the entire project and that the first unit will be completed in less than two years.

Design plans and construction specifications were prepared in the Engineering Department of the Sanitary District under the direction of William H. Trinkaus, chief engineer and Orville Eltinge, engineer of sewer design.

Sludge digester explodes at Herkimer, N. Y.

An explosion that blew off the fixed concrete roof of a sludge digestion tank occurred at the Herkimer, N. Y., sewage treatment plant on Nov. 19. Four men who were working on the tank roof at the time escaped injury, and there was no apparent damage to the cylindrical side walls of the tank.

The damaged 28 ft. dia.-tank which served as a primary digestion unit, was adjacent to a secondary digester whose floating cover contained about 2,000 cu. ft. of stored gas. The latter, however, was not disturbed by the explosion.

An investigation of the cause is being made by Henry W. Taylor, consulting engineer of New York City.

D. & R. G. W. opens new Tennessee Pass Tunnel

The new 2,500-ft. single track tunnel under Tennessee Pass west of Leadville, Colo., was opened by the Denver & Rio Grande Western Railroad with appropriate ceremonies on Nov. 3. F. C. Hogue, general traffic manager for the railroad, headed a party of D&RGW traffic representatives from all parts of the country attending the dedication ceremonies.

The new tunnel supplements an old single-track tunnel alongside, built in 1890 at the time the standard gage line from Denver to Salt Lake was first opened. The old tunnel will be relined with concrete to provide greater clearances and will be continued in service.

The new tunnel, driven by Winston Bros. Company, Minneapolis, has a 23-ft. vertical clearance inside of lining. Contrary to the practice on most railroad tunnels at the top of a grade, the new Tennessee Pass tunnel was driven entirely upgrade from the west end without the usual apex in the center. A feature of the tunnel driving was the use of a top drill carriage that rode on the wall plates. The tunnel was driven at a cost of some $800,000.

Water pollution defined by Indiana board

Regulations setting out what constitutes a polluted condition of waters were adopted at a recent meeting of the Indiana stream pollution control board.

The regulations are to be submitted to James A. Emmert, attorney general, and Governor Ralph F. Gates for approval before promulgation by Rue J. Alexander, secretary of state.

They set out five major conditions defining pollution, including:

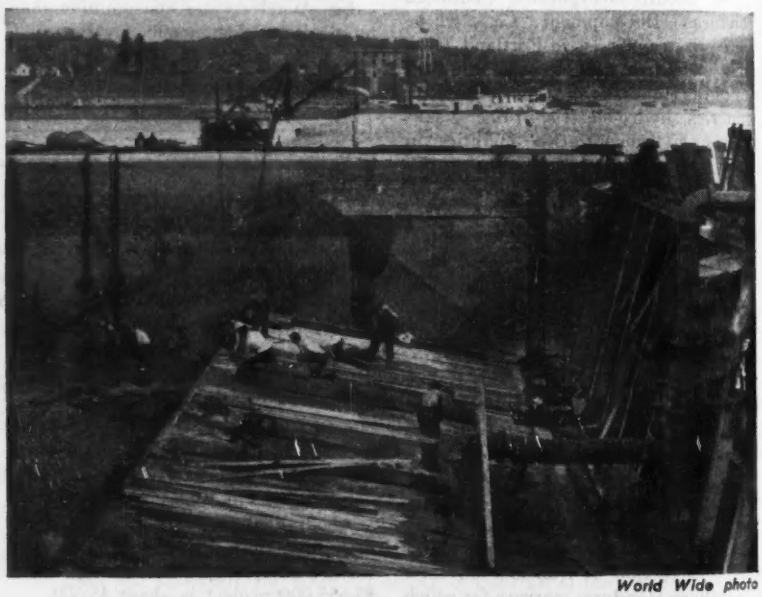
1. Floating material discharged into surface water and in an amount sufficient to injure fish and animal life.

2. Waste discharged into any water containing materials that would cause putrescent or otherwise objectionable sludge banks.

3. Waste discharged into any water containing materials that adversely affect public health.

4. The oxygen content of the receiving water, after being mixed with and affected by waste shall be no less than 50 percent.

5. Receiving water shall be considered unsuitable for bathing if the coliform concentration exceeds 1,000 a 100 milliliters, (a bacteriological measurement).



World Wide photo

Army Engineers repair an Ohio River dam

A $45,000 repair job is being done on the 22-year-old Ohio River Lock and Dam No. 34 about 37 miles east of Cincinnati. Over 200 men are employed there under the direction of U. S. Army Engineers.

The picture shows the cofferdam, the floor of which is 18 ft. below water. It was needed to enable workmen to replace worn steel plates and rollers on upper and lower overlapping leaves of the No. 2 "beartrap". These traps are controllable 91-ft.-wide concrete-walled sluiceways which assure at least a 9-ft. navigation stage.

This dam is one of about 50 such aids to navigation constructed by Army Engineers along the Ohio River's 981 miles.

California to build tourist tramway

Revival of a unique engineering project took place on Nov. 12, when California's Governor Earl Warren made final appointments to the Mt. Jacinto Winter Park Authority.

The authority was set up during the recent session of the state legislature as a non-profit group to sponsor the construction and operation of a $2,000,000 mountain tramway at Palm Springs in southern California. Original engineering and economic surveys were begun in 1939 by Modjeski & Masters, consulting engineer, of Harrisburg, Pa.

The 12,400-ft. tramway will be the world's longest, with a vertical lift of 5,800 ft. Cars to accommodate 46 passengers will travel at about 1,000 ft. per minute. Winter vacationists will be transported from the warm climate of Palm Springs to the snow area a few air-line miles away. A road from Palm Springs to the lower terminus of the tramway at the entrance of Chino Canyon, is part of the project. The upper end of the tramway will be at 8,460 ft. elevation.

The 7-man authority is authorized to issue a maximum of $3,000,000 in revenue bonds to finance the venture. It is expected that R. G. Cone, associate engineer on the preliminary survey and engineer on the Golden Gate Bridge, will be retained when construction begins.

Gov. Warren's appointees were Harold English, Los Angeles business man, Leonard Firestone, of Firestone Tire & Rubber Co., and Jack MacKenzie, a prominent California sportsman. Others on the authority are James Nusbaum, retired engineer of Idyllwild, Calif., and E. W. Grubbs, Riverside building contractor, both appointed by the Riverside County Board of Supervisors. The Palm Springs city council appointed Earl Coffman, hotel man, and John R. Chaffee, Palm Springs publisher.

Appoint California water board members

Governor Earl Warren, of California, recently announced appointment of seven members—five of whom are civil engineers—to the newly created state water resources board.

The board will draft plans for the state's participation in about $400,000,000 of federal water and flood control programs. The group has no power actually to authorize water projects, but its recommendations are expected to be heeded by federal officials and the state engineer's office.

The appointees include: R. V. Meikle, Turlock, chief engineer for the Turlock Irrigation District; Howard F. Cozzens, Salinas, Monterey County surveyor: B. A. Etcheverry, Berkeley, a professor at the University of California who has acted as consulting engineer for the state reclamation board for many years; C. A. Griffith, Azusa; Lester Ready, San Francisco, formerly chief engineer of the California Railroad Commission.

Dam and tunnel project authorized in Oregon

The Oregon State Hydro-electric Commission has issued a permit to the California-Oregon Power Co. of Medford, Ore., for development of the $4,000,000 Toketee project on the North Umpqua river, about 50 miles from Roseburg.

The development calls for a 35-ft. dam at Toketee Falls, with a tunnel 7,500 ft. long to the mouth of Glide Creek. The company plans to install two turbines of 28,000 hp. each and construct a transmission line from the Toketee plant to its substation at Dixon, near Roseburg. Work will be carried out in 1945 and 1946, according to J. C. Boyle, company president.

To evict 1,000 families for Hollywood Parkway

Obstruction of highway work was threatened in Los Angeles, Calif., last week when representatives of 1,000 families, who were given notice to vacate property located in a 7.8-mi. stretch of right-of-way for the new Hollywood Parkway, voiced strenuous objections.

The state highway commission, whose agents began acquiring property for the project in 1939, had leased the property to former landlords for rerental with a 30-day eviction clause. Officials of the commission pointed out that immediate action was necessary in order to take advantage of federal aid on the project, the time limit of which expires June 1, 1946.

With an acute housing shortage in the Los Angeles area, attempts are being made by civil agencies to aid the evicted families. Affected are many wives whose husbands are still in the service.

The state commission has already allotted $4,426,000 for portions of a 4.1-mi. section which includes the novel 4-level grade separation, first of its kind in the U. S. (*ENR* Mar. 23, 1944, vol. p. 425). It is estimated that two years will be required to build the 4-level structure. Similtaneous work on other sections will permit opening the freeway to traffic in 1948.

Much surplus material being used at Coulee

According to Bureau of Reclamation officials, many surplus war materials are being put to work in peacetime construction at Grand Coulee Dam. They pointed out that purchasing this equipment at only a fraction of the original cost will help the Bureau keep construction expenses at a minimum and will save war agencies storage expenses.

Barrage ballon winches, used in Seattle, Wash., as part of the network of defenses for the Boeing Aircraft Co., will be slightly altered and converted to hoist metal, wood and other supplies in connection with spillway work. They originally cost $2,200 but were acquired by the Bureau for $150 each. Two hundred metal liferafts, to be used as catwalks on spillway repair at the dam, have been acquired.

Other wartime surplus equipment purchased includes three concrete pumping machines, gasoline-driven generators, eight air compressors for jackhammer operations and several water pumps. Repair and maintenance shops at the Dam are being equipped with wrenches, saws, screwdrivers and similar small tools.

Kennedy employed over civil service objection

Objection to the San Francisco Board of Public Works award of a contract to Clyde C. Kennedy, consulting sanitary engineer, were withdrawn last week when W. L. Henderson, secretary of the Civil Service Commission, accepted a ruling by City Attorney J. J. O'Toole.

A controversy started recently when civil service employees challenged the right of Harry C. Vensano, public works director, to employ the Kennedy firm when city engineers were available. Vensano signed the contract to provide plans and specifications for a sewage disposal plant at a cost of $77,000 in an effort to rush postwar construction after learning that civil service manpower was not immediately available (*ENR* Oct. 11, vol. p. 474).

O'Toole's opinion stated that since Kennedy was an independent contractor and his employees were non-civil service, the commission had no voice in the matter. Observers said that the opinion applied only to Kennedy's case and was not a ruling that could be applied to all similar cases that might arise in the future.

WASHINGTON HIGHLIGHTS

• ***Planning aid asked***—Applications to the Bureau of Community Facilities, Federal Works agency, for federal aid for planning local public works totalled $31,822,000 on Oct. 31, George H. Field, commissioner of the bureau, told the New Jersey League of Municipalities last week. The requests were to aid in planning work estimated to cost over a billion dollars. Advances totalling $10,108,000 had been approved up to that date, Commissioner Field said. Since the agency was given only $17,500,000 by Congress for assisting local planning groups, a request for $50,000,000 more has been made, as well as for the power to enter into contractual obligations for $57,500,000 more (*ENR* Oct. 25, vol. p. 556). For later news on this request see p. 51, this issue.

• ***Lumber stock down***—The Office of the Chief of Engineers announced Nov. 16 that the Army's stockpile of lumber, which during the war averaged a half billion bd. ft., has dwindled to less than 26 million bd. ft. This amount is a record low. Conservative estimates indicate that amount will furnish Army requirements until after Jan. 1, 1946. The present supply is made up mostly of large-size timbers and cants, ranging from 6 x 6 to 12 x 12-in. material. Little plywood is on hand.

It was also announced that the Engineers, who bought and used more than 23 billion board feet of lumber between 1941 and V-J Day, have moved 150 million feet of lumber since August 15—20 million feet of it being handled between the 1st and 15th of November. Practically all the heavy timbers on hand are being recut into standard sizes for new construction, repair, and packing and crating.

• ***Authorize new bridge***—A bill (S. 1219) authorizing the city of Saint Francisville, Ill., to construct and operate a bridge across the Wabash River was passed Nov. 7 by the House. On the same day that body also approved an act extending the time for commencing and completing construction of a bridge across the Mississippi River at Mill St. in Brainerd, Minn.

• ***Housing bill***—A bill seeking to stabilize housing conditions by creation of an Office of Housing Stabilization headed by a director with power to place price ceilings on all housing was introduced last week by Congressman Wright Patman, of Texas.

The bill (H.R. 4761) was introduced as an amendment of the National Housing Act, is designed specifically "to prevent speculation and excessive profits in the sale of housing" and to insure the availability of real estate for housing purposes at "fair and reasonable prices."

• ***New courts building***—Authority for the Architect of The Capitol to construct at a cost of $10,500,000 a new building for the U. S. Court of Appeals in the District of Columbia, is provided in bill S. 1603 and H.R. 4719, introduced in the Senate and House Nov. 16. The land has already been obtained for the project. The federal and District of Columbia governments would share the cost of the work.

• ***Sludge gas for heat***—Surplus sludge gas developed at the central sewage treatment plant of Washington, D. C., will be sold to the National Capitol Housing Authority to heat 600 dwelling units at the Bellevue housing project, according to Harold A. Kemp, director of sanitary engineering for the district. The gas is being sold for 15c. per thousand cu. ft. and is expected to result in a $12,000 yearly revenue. Actually the delivery of gas started some time ago but the contract to pay the District has just been signed.

• ***Construction committee transferred***—The committee on construction, formerly headed by Hugh Potter, who resigned as construction coordinator Nov. 1, will function through the office of Robert R. Nathan, deputy director for reconversion, it has been announced by John W. Snyder, director of War Mobilization and Reconversion. Alvin I. Brown, who was special assistant to Mr. Potter, will have direct responsibility for the committee's work under Mr. Nathan. Mr. Brown is a construction engineer and president of the Aldon Construction Co., Washington, D. C.

JOBS OF THE WEEK

FACTORY, Los Angeles, Calif.

Swinerton & Walberg Co., Los Angeles, Calif., has been awarded a contract for factory additions by American Can Co., Los Angeles, to cost about $1,000,000. J. Abbey, Los Angeles, is the company engineer.

ICE PLANT, Salinas, Calif.

Shippers Development Co., Salinas, awarded a contract for an ice plant with forced draft cooling towers, to Associated Refrigerating Engineers, Los Angeles. The estimated cost is $750,000-$1,000,000. Charles E. Butner, Salinas, is the architect.

RESIDENCES, Venice, Calif.

J. Paul Campbell, Los Angeles, will construct 200 frame and stucco dwellings for Homes & Wholesale Co., Los Angeles, to cost about $1,200,000.

FACTORY, El Monte, Calif.

Ball Brothers, Muncie, Ind., awarded a contract for a factory to manufacture glass containers by its own forces. The estimated cost is $4,000,000.

HOTEL, Evanston, Ill.

Northwestern University, Evanston, awarded a contract for a 7-story hotel to R. C. Wieboldt Co., Chicago, Ill., at about $2,000,000. Holabird & Root, Chicago, are the architects.

WIND TUNNEL, Daingerfield, Tex.

Bureau of Yards & Docks, Navy Department, Arlington, Va., awarded a contract for the construction of a wind tunnel to Pittsburgh Des Moines Steel Co., Pittsburgh, Pa., at $1,529,530.

STORE, Cincinnati, O.

B-W Construction Co., Chicago, Ill., will erect a store addition for Sears Roebuck Co., Chicago, Ill., to cost about $1,000,000. Nimmons, Carr & Wright, Chicago, are the architects.

RUNWAY and TAXIWAYS, Moffett Field, Calif.

Frederickson & Watson Construction Co., Oakland, Calif., has been awarded a contract for runways and taxiways at the Naval Air Station by Bureau of Yards & Docks, Navy Department, Arlington, Va., at $1,446,454.

Note—Additional bidding and contract news on many projects large and small, including the above items, appear in the Construction News section beginning on page 145.

OBITUARY

Willis C. Bickford, chief engineer and general manager of the port of Seattle, Wash., died Nov. 4.

George H. Tingley, reclamation engineer, died Nov. 13 in Oakland, Calif. Since 1942 he had been engaged in the engineering work at Mare Island Navy Yard. Associated with the Bureau of Reclamation from 1934 to 1942, Mr. Tingley assisted in field and final location surveys for many major reclamation projects in Utah.

Alfred C. Schrader, 82 formerly superintendent and chief engineer for the west parks system in Chicago, Ill., died Nov. 9. A graduate of the University of Illinois in 1885, Mr. Schrader had been with the system 26 years until his retirement in 1922.

Fred C. Lang, 59, Minneapolis, Minn., professor of highway engineering, University of Minnesota, died Nov. 19. He was graduated from Minnesota as a civil engineer in 1908. He spent two years with the U. S. Reclamation Service, five years as city engineer of Chisholm, Minn., and three years as a material manufacturer. He became an instructor at Minnesota in 1918 and shortly afterwards took on the position of material and research engineer with the Minnesota State Highway Department on a parttime basis.

Harry E. Cotton, 64, drainage engineer with Armco Drainage and Metal Products, Inc., died recently at Middletown, Ohio. He was graduated from Iowa State College in civil engineering in 1906. His early engineering work was with the city of Omaha, Neb., where he later became assistant city engineer. He joined the Armco Culvert Manufacturers Assn. in 1928, and in 1931 transferred to the New England Metal Culvert Co. at Boston. In 1936 he returned to the association at Middletown.

Ralph J. Collentine, 53, former civil engineer of Delavan, Wis., died Nov. 20.

James Lakeman Ward, 63, a retired engineer, died Nov. 24 in New York City. At one time he was vice-president of the Goethals-Wells Engineering and Construction Co., and built many public and private structures.

Lloyd D. Smoot, 66, engineer with the District of Columbia Highway Department for 26 years, died Nov. 19 in Washington. Mr. Smoot was graduated from Cornell University and became associated with the highway department in 1901. In 1911 he was named commissioner of public works in Jacksonville, Fla., where he served until 1917. During the first World War Mr. Smoot served as captain with the Engineer Corps. He returned to the District government in 1929 as engineer of design with the highway department.

MEN AND JOBS

The appointment of **Lieut. Col. Edward G. Wetzel,** of Crestwood, N. Y., as highway analyst for the Port of New York Authority has been announced. Colonel Wetzel, highway and transportation specialist in the United States Army for more than four years, will take the place of Guy Kelcey, resigned. Colonel Wetzel, whose experience includes eight years with the Indiana State Highway Department, has a degree in civil engineering from Purdue University. He also studied for a year at the Bureau for Street Traffic Research at Yale University. He will now work with federal, state and local highway officials in the development and improvement of highways in the port district, particularly those which connect with the authority's bridges and tunnels and its freight terminal facilities.

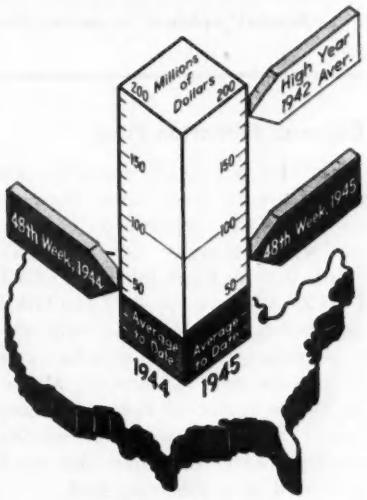
J. H. Dowling, chief engineer of Florida State Road Department has resigned after 22 years of service. He will take over a building material dealership in Tallahassee. As chief engineer he had supervision of such major construction as the Overseas Highway to Key West and the road through the Everglades from South Bay on Lake Okeechobee to Miami.

J. Roy Gilley, civil engineer, has been appointed director of the University of Toronto's new Ajax Division—the separate college in which first year engineering ex-service students are to be accommodated beginning January. **W. J. T. Wright,** professor of engineering drawing, is to be director of studies for the Ajax project.

Jules Archambault has been appointed chief engineer of the Montreal Tramways Co.

(*Continued on page* 107)

CONSTRUCTION ACTIVITY



As Reported This Week to...
Engineering News-Record

CONTRACT VOLUME

Continental U. S. Only
(Thousands of Dollars)

	Week of Nov. 29 1945	Cumulative 1945 (48 wk.)	Cumulative 1944 (48 wk.)
Federal	$7,285	$729,323	$1,057,870
State & Mun.	6,893	350,062	230,405
Total Public	14,178	1,079,385	1,288,275
Total Private	45,444	972,014	348,221
U. S. Total	**$59,622**	**$2,051,399**	**$1,636,496**

WHERE CONSTRUCTION ACTIVITY ORIGINATED THIS WEEK

Dollar Volume (Thousands)

Type of Work	This Week	Cumulative 1945 (48 wk.)	Cumulative 1944 (48 wk.)
Waterworks	1,207	$53,962	$30,298
Sewerage	1,215	31,874	30,306
Bridges	234	40,007	15,075
Highways	969	206,475	184,756
Earthwork, Waterways	2,886	54,086	62,588
Buildings, Public	2,938	448,483	614,493
Industrial	24,728	545,746	166,126
Commercial	17,738	312,401	134,270
Unclassified	7,707	357,706	398,584

NOTE: Minimum size projects included are: Waterworks and waterway projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1945 (48 wk.)	Cumulative 1944 (48 wk.)
NON-FEDERAL	$703,939	$421,069
Corporate Securities	185,811	106,720
State and Municipal	383,528	169,409
RFC Loans	24,600	61,940
REA Loans	60,000	20,000
Fed. Aid Highway	79,000	63,000
FEDERAL	1,049,898	1,263,800
Total Capital	$1,782,837	$1,684,869

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	Nov. '45	309.28	148.67
Building Cost	Nov. '45	240.55	130.00
Volume	Oct. '45	167	73

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Chicago Filtration Plant

Sir: In your article describing the use of special steel forms for constructing the reinforced concrete washwater troughs for Chicago's South District Filtration plant (*ENR* June 28, 1945, vol. p. 989) you failed to mention our connection with the work, although you did give the name of our concrete foreman, F. Miller. As subcontractor of Robert Gordon, general contractor, we performed this concrete work including the form work and the reinforcing steel.

The officers of our company spent considerable time and thought over the proper and economical procedure for concreting the troughs and we believe the proper acknowledgement of our responsibility for its success should be made.

For the information of your readers, the concrete mix for these washwater troughs was designed by Robert W. Hunt Co., and checked and approved by engineers under O. E. Hewitt, commissioner of public works, Chicago. The mix we used was 6.5 sacks of cement, 0.482 cu. yd. of torpedo sand and 0.566 cu. yd. of pea gravel. The average compressive strength of the concrete at seven days was 4,150 psi.

R. F. KIRKMAN
Vice President
J. W. Snyder Co.
Chicago, Ill.

Collimator Big Help

Sir: I have read with a great deal of interest the article "Collimators Permit Rapid and Accurate Adjustment of Surveying Instruments" (*ENR* Oct. 18, vol. p. 502).

If, as this article indicates, so few state highway departments and municipalities include a collimator in their equipment, I think it would be wise to give this subject more publicity. We feel that you have understated the advantages gained by the possession and use of a collimator.

This thought is based on our experience since 1925, at which time we induced one of the large manufacturers of surveying instruments to make a collimator for us. We have found it to be one of the most valuable instruments in our equipment. In the construction of our collimator, two more or less obsolete wye levels were used, thus materially reducing the cost. While I imagine our set-up is rather crude when compared with the one described in your article, we find it is very practical and takes care of our needs.

ROBERT JERRETT
Location Engineer, Div. of Roads and Bridges, State Dept. of Public Works, Providence, R. I.

Great Falls Water Tank

Sir: In your recent article on the prestressed concrete water tank at Great Falls, Mont. (*ENR*, Oct. 4, vol. p. 435) you state that the vertical steel is prestressed to overcome horizontal cracks that appear in tanks of this type. As you say, it is difficult to show just how these walls can get into tension vertically. Such cracks can occur, however, for the following reasons:

In prestressing a circular concrete tank the hoops create horizontal compression in the wall but at the same time they induce tension in the vertical direction in accordance with Poisson's ratio. That means for a compression of 1,000 psi., the wall tension is from 100 to 150 psi. Actual tests on concrete pipe conducted at Purdue University and published in the *Bulletin* of the Engineering Experiment Station by Prof. R. B. Crepps show the existence of this tension.

Furthermore, the temperature stresses set up in a concrete wall can produce stress sufficient to crack plain concrete. This can happen the easiest when a cold piece of concrete is exposed to the sun, warming the wall on the exterior while the interior is relatively cold. Concrete pipes have been known to crack at times in the fall and spring from this stress alone.

In a structure such as the Great Falls water tank local bending stresses are set up in the concrete directly under the large bars where the spacing between bars is wide. This would tend to create cracks on the inside of the tank directly under the bar. Mr. Freyssinett has discussed this in a published article describing construction of a large diameter conduit prestressed with wire cables. The project was located in France.

Where embedded reinforcing steel has been used for so-called temperature steel it tends to create cracks when the concrete shrinks during the process of setting up. Elimination of this steel during the pouring of the concrete would result in a more watertight wall.

In a tank such as the one at Great Falls, Mont., the character of the wall in section due to variations in thickness, especially in the top portions, result in variable deflections which create stress in the wall. If it is assumed that the empty tank when fully prestressed has no variations in deflection, then the tank will expand outwardly when filled with water. This expansion would be uniform throughout the wall except that the parapet has practically no movement and the base movement is resisted by the friction and ties to the base. As a result the wall bends and tension or compression is induced. Without prestressed steel it is possible that this will crack the wall.

In producing prestressed concrete pipe we have always prestressed the steel to improve the strength of the pipe as a beam and to eliminate other stresses as shown above. It is possible to have watertight walls 3 in. thick at 300 psi. pressure.

PAUL L. OSWEILER
Price Brothers Company
Dayton, Ohio

Curves for Hankinson Formula

Sir: W. F. Parsons (*ENR* Oct. 18, 1945) gives a graphical method that he prefers to the Hankinson formula. He wonders whether mathematicians can find anything wrong with it. The most serious objection to it is an engineering one—it does not agree with the best available experimental data as represented by the Hankinson formula.

Mr. Parsons attaches great importance to curves that cut the horizontal and vertical axes at right angles. The

reason is not clear. At any rate, he is mistaken in thinking that an ellipse is the only curve with this property. A parabola can be drawn so as to meet the same conditions. For an easy graphical construction, see "Railroad Curves and Earthwork", by C. Frank Allen, 6th Edition, p. 72. A hyperbola can also be drawn normal to the same lines. Presumably, an unlimited number of algebraic curves above second degree could be found to meet the same conditions.

If Mr. Parsons still prefers an ellipse, I suggest that he lay off the square roots of P and Q, respectively, as major and minor semi-axes, instead of P and Q. Scaling the radius vector, as before, will give the square root of the permissible diagonal stress in exact accordance with the Hankinson formula.

JEROME FEE
Senior Engineer
Federal Power Commission
San Francisco 2, Calif.

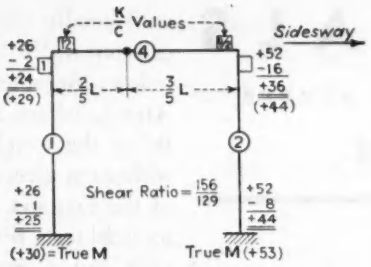
Plotting Hankinson Formula

Sir: The ellipse that W. F. Parsons (*ENR* Oct. 18, 1945, vol. p. 486) proposes as a substitute for the Hankinson formula gives values as much as 16 percent less. There seems no reason for using the less correct ellipse when the Hankinson formula can be so easily plotted in polar co-ordinates to give a curve with the appearance of a "bulged ellipse" from which values for angles intermediate between 0 and 90 deg. can be scaled just as easily. Analytically, the difference between the curves can be readily seen if the equation of the ellipse is also written in polar co-ordinates with the center as pole, but any formula for the difference would be too long to be useful.

J. B. MACPHAIL
The Shawinigan Engineering Co. Ltd.
Montreal, Canada

Sidesway in Frames

Sir: In *ENR* Aug. 9, vol. p. 92, J. J. Polivka demonstrated a direct distribution of the fixed end moments due to sidesway on an unsymmetrical frame by use of the node points. Although the solution given is virtually complete, it may not be out of order to point out that the final moments shown are only proportionately correct. After distribution there is a



Sidesway in unsymmetrical frame calculated by direct moment distribution, using node point of BC.

loss of shear in the column legs and, therefore, to be consistent with statics the moments must be modified by the ratio of the shear before the joints were balanced to that existing afterwards.

By utilizing the node point of the horizontal member BC, which may be ascertained from the "fixed" or "conjugate" points, similar results—a direct distribution—may also be obtained with the end rotation constants as illustrated for the same unsymmetrical bent used by Mr. Polivka.

$$1/c \text{ (for BC)} = \frac{3/4}{1 - 1/2 \times 3/2} = 3$$

$$1/c \text{ (for CB)} = \frac{3/4}{1 - 1/2 \times 2/3} = 9/8$$

The true moments, corrected for shear, are listed in parentheses.

M. W. ROSENSTEIN
Chicago, Ill.

Consider Service Men

Sir: I read with keen interest the editorial entitled "First In, Last Out" (*ENR* Sept. 6, vol. p. 283).

The last sentence suggests that construction men will deserve the utmost in praise and help that a grateful nation can bestow. That suggestion can be put into practice by postponing Civil Service examinations until a large majority of men have been released from service. The men in service are entitled to an opportunity to compete for Civil Service positions, but fully as important, is the benefit to be derived by the citizens of each municipality, state and the country as a whole. Many of the men in service have acquired abilities which they can bring to these positions, and the people should not be deprived of these talents.

A grateful nation can bestow not merely praise but can give material help to men in service by making temporary appointments where necessary, and by postponing examinations for permanent appointments in Civil Service until the large majority of men now in the armed forces have the opportunity to compete for these positions.

SETH G. HESS
New York, N. Y.

Avoiding Sand Pockets in Gunite

Sir: In the article "Gunite Tunnel Lining Test Reveals Difficulties in Application" (*ENR* Nov. 1, 1945, vol. p. 579), reference is made to sand pockets which occurred behind the large circumferential rods. The article also states that the operator was a man with 17 years' experience in Gunite work, but it appears to us that he could not have had the necessary experience in this kind of shooting to get such unsatisfactory results. Frequently we have had occasion to shoot Gunite through and behind reinforcing more closely spaced than the picture in the article shows, and running in two directions rather than one, always with satisfactory results.

For shooting of this type, it is impossible to apply the material at right angles to the forms without causing sand pockets behind the rods. By proper weaving back and forth, that is from east to west and from north to south, sand pockets can definitely be avoided.

It must be understood that Gunite is a specialty construction, and it takes time and care to train men to become expert in applying it.

JOHN H. HESSION, President
National Gunite Corporation
Boston, Mass.

Old Waterloo Bridge

Sir: The reference to the "old Waterloo Bridge" in *ENR* of July 19, p. 15, is rather misleading. The "old" bridge was a masonry arch structure too weak for modern traffic. It was replaced in recent years by a concrete arch bridge. During the demolition and reconstruction, which occupied several years, traffic was accommodated by a temporary steel bridge, which evidently is the structure now to be reerected in Holland.

E. E. R. TRATMAN.
Associated Editor Retired
Engineering News-Record
Wheaton, Ill.

EDITORIALS

VOLUME 135 NUMBER 22

November 29, 1945

A Big Assignment

ESTABLISHMENT in the U. S. Department of Commerce of a special division to coordinate data from both government and private agencies on the varied phases of the construction industry, as announced recently, is a necessary and promising development. If the hoped-for yearly construction volume of $15 billion or more is to be reached and maintained, the industry will need much more and much better informational assistance from the federal government than has been previously available. And if the Murray full-employment bill or something similar should become law, the federal government will require for itself the very best of statistical aids. Since no federal agency at present attempts to combine data covering all the ramifications of construction, establishment of the new division in the Department of Commerce appears logical. But the task of supplying timely statistics and information on such a varied industry is a big and a costly assignment, and the work will require an active, large and well-directed staff. A good step has been made in the selection of John L. Haynes as chief of the division, for he has already won the respect of both industrial and governmental groups in his work with the WPB. If as good results can be had in securing adequate appropriations for the work, the new division will be off to a good start.

Bold Energy Dissipation

A BOLD DEPARTURE from traditional means for dissipating the energy of the water discharged through the spillway of a large dam has been installed at Fontana Dam. Flood flows, which must be dropped 400 ft., are discharged through two inclined tunnels to points in the valley well below the dam. There, the outlets have been given such form as to throw the water, which is then traveling at a rate of 150 ft. per sec., upward and forward, spreading it into a great oval shaped jet that falls harmlessly over a wide area of the river channel below the dam (see p. 86). There are no similar energy dissipators, so far as we can recall, and only two that remotely approach it. One is at Boulder Dam, where discharge conduits equipped with needle valves throw jets from high up on the canyon walls to fall as spray into the channel below; the other is at a much lower dam in South Africa, where steps on the face of the spillway throw the overfall into a spray that falls over a wide area directly in front of the dam. Model tests of the Fontana design have been confirmed in part by field tests with the limited flow that is now available, but as model tests can reveal little of value with respect to erosion in the river channel and along the jet-forming lip at the tunnel outlets, full confirmation of the efficiency of this new device must await a major flood. However, as floods of the magnitude for which the spillway is designed are very rare, even a considerable amount of erosion at such times probably would be far offset by the savings resulting from use of this novel design in place of a conventional overfall spillway with a deep stilling basin.

Driving Timber Piles

RELATIVELY new to the art of driving timber piles is use of an auger or churn-drill to open up a hole through mixed subsurface material and thus avoid beating the pile to a pulp where jetting is not effective. This and other notes on how to handle timber piles so that they will retain their full effectiveness as a column or as a cantilever beam is the subject of an article on p. 83, written by an experienced bridge engineer. Anyone who has seen timber piles pulled or exposed by subsequent excavation cannot but realize how serious overdriving may be. At the surface the piles may appear to be in good condition, but down out of sight they may be badly battered or even sheared. Any device or technique that adds to the certainty of driving timber piles without damage is a welcome addition to the tools of the constructor.

The New Suspension Bridge

WHEN the Tacoma Narrows Bridge shook itself loose from its cables under the force of a relatively moderate wind on Nov. 7, 1940, aerodynamic instability, long known to designers of airplanes, but overlooked by all contemporary suspension bridge designers, entered their consciousness, as well as that of the public, in spectacular manner. Developments quickly followed, but reassuring results were slow and few. For example, existing bridges, particularly the longer, more flexible spans were immediately examined for dangerous vibration; yet we still know too little of what was learned. Then

again, remedial measures were taken on some bridges, but the results have hardly been frankly discussed in public. And finally a committee of bridge specialists was organized to study the whole question of suspension bridge design and to cooperate in extensive wind tunnel investigations initiated by the Washington Toll Bridge Authority as a part of its redesign work on a new Tacoma Narrows Bridge; during four years of activity, secrecy and silence have characterized the program so that only a handful of specialists were familiar with the progress being made.

As perhaps the beginning of the end of this information blackout, however, there is published in this issue an article by Charles E. Andrew on the design for the new Tacoma Narrows Bridge. And as the first report on progress in aerodynamic design it is reassuring, for it indicates that through newly developed wind tunnel techniques on full length bridge models we finally have a means of predetermining the vibratory action of the prototypes. In the case of the new Tacoma Narrows Bridge, for example, it has been shown to have the ability to dissipate (without undue movement) the energy input from the wind at all critical angles and velocities. Contributing to this ability is an "open" structure—i. e., trussed instead of solid-web stiffening members and floor-beams plus three lines of open grating in the floor slab—which reduces the effective wind impulses; a much greater depth of stiffening member compared to the one used on the original bridge (33 ft. as against 8 ft.) so that both vertical rigidity and torsional resistance are substantial; and, finally, the bridge is to be equipped with damping devices to absorb some of the energy. The result is a truly new suspension bridge design that takes aerodynamic considerations scientifically into account.

Earlier suspension bridges were made aerodynamically stable either by the unconscious genius of the designer or by accident. The new Tacoma Narrows Bridge will be provided this characteristic deliberately as the result of study and experiment. Every future long span suspension bridge must likewise utilize these new scientific facts, and every existing bridge of this type should be checked by them. And because these aerodynamic considerations are sure to have far-reaching influence on the design of all long, flexible spans, it is to be hoped that more of the findings of the model studies may soon be made available now that Mr. Andrew has set the precedent.

Problems of Timing Construction

A CONCISE presentation of the facts relating to the question of reducing the violent swings of construction activity has appeared in the report of the committee of construction industry representatives appointed by Maj. Gen. Philip B. Fleming, Administrator of the Federal Works Agency, to advise him on the timing of public works programs (*ENR* Nov. 22, 1945, vol. p. 685). If we are ever to make any progress toward construction stabilization, the inherent difficulties, which the report lucidly set forth must be firmly appreciated.

These difficulties need not be enumerated here, but basically they stem from two causes—the nondeferable character of private construction, and the fact that much public construction is tied to this private work and consequently must advance with it. Therefore, the volume of public work remaining, and theoretically subject to timing, is relatively quite small.

However, we cannot fully subscribe to the conclusions of the committee, which are to the effect that manipulation of public works volume would have little effect on construction in boom periods, but can produce "substantial good" in depression times. Acceptance of this philosophy would presume that public works need never be deferred, but can sometimes be advanced with beneficial results. That this is not the whole story is suggested by the fact that only the effect on construction volume is being considered. There is also the possibility at times (the present for instance) that postponement of public works might well have both a psychological and actual influence in holding down construction costs and, furthermore, would encourage and not compete with private construction.

Careful reading of the report will stimulate other such supplemental thoughts. And that will be all to the good, for some measure of stabilization is desirable however difficult to attain, and it cannot be done without more informed discussion than has existed in the past. The FWA report, with the possible exception of its incomplete conclusions, provides a good base for a beginning.

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Redesign of Tacoma Narrows Bridge

Charles E. Andrew
Chief Consulting Engineer
Washington Toll Bridge Authority

***Contents in Brief**—Design of a new four-lane suspension bridge with a 2,800-ft. span to replace the narrower structure which collapsed in 1940 is based on results of a 4-yr. research program in a specially designed wind tunnel with a throat section of 10x100 ft. Substructure and west approach of original bridge can be used again.*

COLLAPSE OF THE TACOMA Narrows Bridge on Nov. 7, 1940, climaxed experience with vibration on several long span suspension bridges, built in the preceding two or three years, with stiffening girders instead of trusses. The collapse afforded dramatic and emphatic proof that henceforth designers of such bridges must take into account not only the forces previously considered, including wind, but also the possibility of vibration resulting from aerodynamic forces. A replacement structure has now been designed for the Tacoma Narrows crossing in which such considerations have occupied a dominant place.

Two courses open to designers

Prior to the collapse wave motion had been observed in several other bridges, and oscillations of the Tacoma Narrows Bridge itself had induced the Washington State Toll Bridge Authority to initiate a program of wind tunnel experiments in an effort to find a remedy. However, at that time the serious nature of the movements was not fully appreciated. After the failure it was realized that plans for rebuilding must give assurance that the new structure would be of a design in which no such risks would be involved.

The designers preparing plans for a new bridge had the choice of two courses. They could extrapolate from the heavier and stiffer long span bridges which had shown apparent stability but under unknown wind conditions or they could institute research looking to a form of suspended structure which would not be subject to vibrations of objectionable amplitude. The latter course was followed. A wind tunnel with a throat section of 10x100 ft. was built on the University of Washington campus and a research program was begun which has now been under way for nearly four years. Results of this research give assurance of stability in the design now adopted as best for building a new superstructure on the same piers that supported the original Tacoma Narrows Bridge.

Collapse of the bridge was described in *ENR* Nov. 14 and Nov. 21, 1940. Later, dismantling of cables and towers was reported in issues of Aug. 26, 1943, vol. p. 347 and Oct. 21, 1943, vol. p. 602, respectively.

After unspinning the main cables and dismantling the towers, total value of remaining portions of the structure was estimated at $3,250,000. Included in this estimate were the main piers and those parts of the anchorages and the west approach which remained intact and could be utilized in a bridge of new design. Since the piers had been put down in very deep water (total pier depths are 175 and 225 ft., respectively) where tidal currents of high velocity are involved, the piers constitute a very important part of the bridge project as a whole. Traffic over the original bridge, during its brief existence, indicated that a structure of considerably greater cost would have been justified.

New design features

Starting with the old substructure in which the main span would be 2,800 ft., and following the principles established by wind tunnel tests to avoid objectionable vibration, a design was developed for a four-lane structure with a cable spacing of 60 ft. and a cable sag ratio of 1:10. As compared to the 8-ft. deep plate girder stiffening members of the old bridge this new design has stiffening members of the trussed type, 33 ft. deep with an I of about 7,000,000 $in.^4$ per truss. All members are designed to present the least possible frontal area to winds. Open truss floorbeams are used (the old bridge floorbeams were plate girders) and the roadway is slotted, that is, it has open gratings between traffic lanes. Incidentally, these slots provide excellent dividing lines between the lanes. The solid portion of the roadway is to be made of lightweight concrete.

Although cables of the original bridge were only 39 ft. apart, the tower legs were battered and the spread at the base was 50 ft. The piers are long enough to accommodate the 60-ft. spacing of the new tower legs.

New bridge 50 percent heavier

In the new bridge the greater weight of the superstructure (about 50 percent more than the original) will increase the foundation loads less than 1 ton per sq.ft. Since both piers are founded on well graded gravel and sand with deep overburden, such an increase will be of no consequence. Like the piers, the anchorages remained intact after the collapse and a considerable part of them, at least 60 percent, can be used for the new superstructure.

The new design includes external energy absorbing devices whose purpose is to furnish additional damping in the structure. These devices are hydraulic cylinders at the towers and in the diagonal ties at the center of the main span. They act elastically up to a certain point. This elastic action is adjustable and can be limited to the point beyond which undue stresses

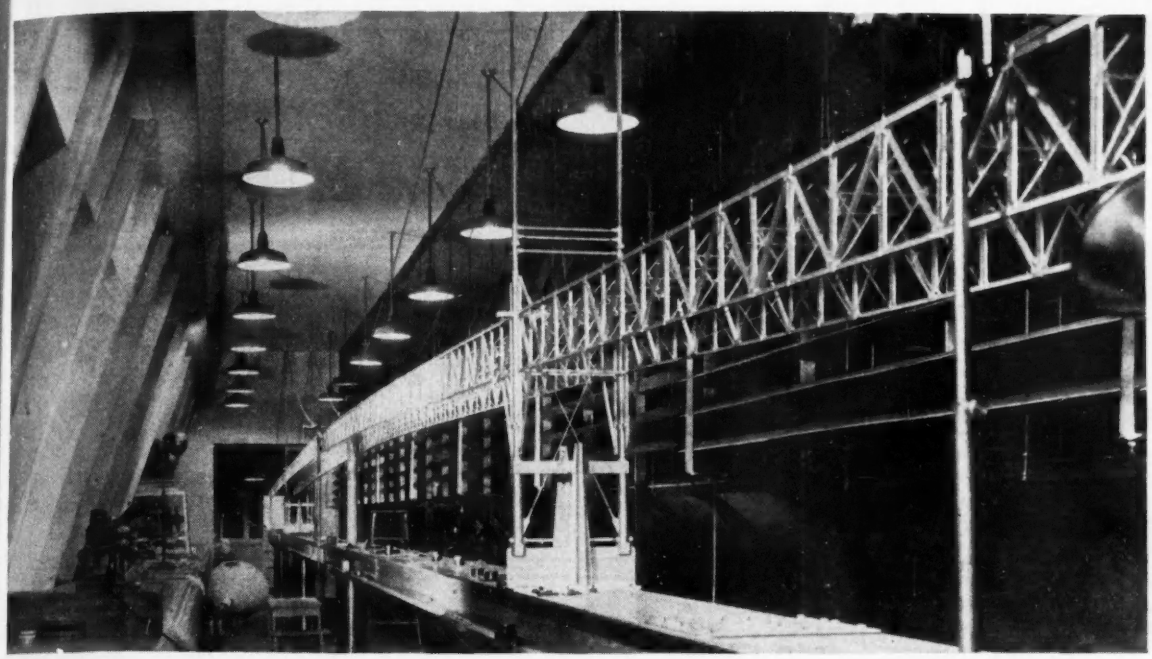

Fig. 1. Full-length scale model of the proposed Tacoma Narrows Bridge, 100 ft. long, is mounted in the wind tunnel ready for one of the numerous tests to which it was subjected.

might be induced in other parts of the structure from expansion or live load deflection.

Steps leading up to these fundamental features of design may be summarized as follows: The first requirement of the new design was that it should reduce, as far as possible, the intensity of the wind impulse forces and thereby reduce the tendency to motion and the amount of energy which the bridge would be called upon to dissipate. Such a plan would lead to economy by reducing weight and permitting the use of four traffic lanes without undue increases in load on the existing foundation.

No precedent for aerodynamic form

There was no bridge precedent to determine the best aerodynamic form other than the self-evident fact that the original Tacoma Narrows Bridge and other existing bridges of similar form were decidedly deficient in this respect. On the other hand, existing bridges with open construction in the stiffening systems, open hand rails, etc, had given little trouble. Thus it appeared that if the effect of wind forces could be reduced, and component parts of the suspended structure could be made of a number of small members rather than a single large member, the aerodynamic forces exerted on the small members might cancel out or, at least, oppose each other to some extent.

Placing open slots in the roadway allows air to move through it to a considerable extent and thus tends to cancel the fluctuating pressures and to increase turbulence. With this arrangement, as shown by wind tunnel tests, effective impulses can be so reduced that the ability of the structure to dissipate energy is sufficient to balance the energy input resulting from wind. The work equation is thus satisfied without exceeding a safe range of movement.

The design shown in the accompanying drawing was developed step by step. Tests with a model having a continuous concrete floor slab and a truss form of stiffening showed vibrations very much less than on the model built according to the original bridge design. However, these vibrations were still beyond desirable limits. Seventy-six variations, several of which were tested with varying moments of inertia, were studied successively in model form. The final and most satisfactory type of roadway was that with the slots or open grating as shown in the drawing.

Making model tests

No record was found of any aerodynamic research applied to bridges prior to the failure of the Tacoma Narrows Bridge. Original research therefore was required in any comprehensive solution of the problem. This suggested the use of three dimensional models. The scale of such models would have to be small in order to keep the dimensions of the air jet within reasonable limits, yet if the scale were made too small it would be impossible to simulate elastically the bridge members. The wind velocities would be very low when compared with those in tunnels used for airplane experiments, and thus problems relative to obtaining proper airflow and accurately measuring the low velocities had to be worked out.

Scale model 100 ft. long

The scale adopted was 50:1 which, for the Tacoma Narrows site, called for a model 100 ft. long and required an air jet about 4 ft. wide and 100 ft. long. The model was mounted on a steel I-beam base (Fig. 1) supported on four hydraulic jacks which permitted it to be raised and lowered. The air stream was a return flow arrangement in which constant air velocity was maintained by ten propellers each 7½ ft. in diameter and driven by a 75-hp. motor.

Since no comparable experiments ever had been made on aerodynamic models subject to turbulent flow, there was no assurance that the ac-

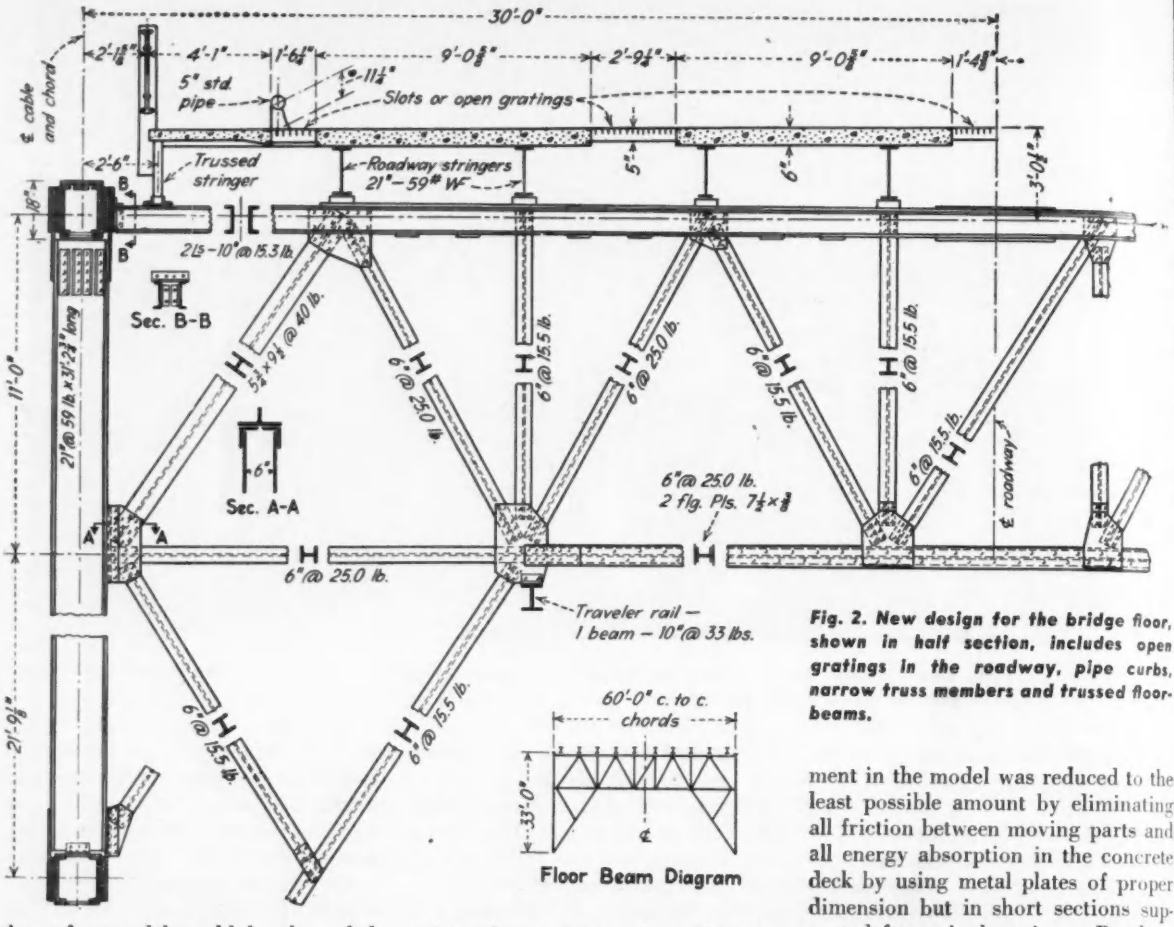

Fig. 2. New design for the bridge floor, shown in half section, includes open gratings in the roadway, pipe curbs, narrow truss members and trussed floor-beams.

tion of a model could be depended upon to predict the action of the prototype. Fortunately, quite accurate observations and measurements of the modes of motion and amplitude for different wind velocities of the original Tacoma Narrows Bridge had been recorded. This afforded a means of checking the wind tunnel results because the first model was built to exactly follow the design of the original Tacoma Narrows Bridge.

When this 50-scale model was found to perform substantially as did the bridge itself under corresponding winds, it was felt that other bridge designs could be tested with reasonable assurance that the action of the prototype could be predicted from the tests. In other words, the wind tunnel was "calibrated" by the model of a prototype whose reaction to various wind conditions had been well established before the model was built.

In the design and construction of this wind tunnel and the models it was to test, many new techniques had to be developed. Some of these are of major importance in predicting the action of a prototype from data recorded on the model. Three important examples are cited:

First, the ability of a suspension bridge to dissipate energy has never been determined. Different bridges may have different abilities in this respect depending on various factors such as stiffness, character of riveting, intensity of stress, amplitude, friction at sliding stringer connections and end shoes, position and amount of energy dissipation in concrete floor slabs, air damping, etc. An opportunity to determine this characteristic was overlooked in the original Tacoma bridge because its importance was not realized at the time.

Decrement determination important

The determination of at least an average decrement for several types of suspension bridges is one of the most important steps yet to be established in the solution of this problem. Since the decrement of the original Tacoma Narrows Bridge was not known, it could not be duplicated in the model. Therefore the decrement in the model was reduced to the least possible amount by eliminating all friction between moving parts and all energy absorption in the concrete deck by using metal plates of proper dimension but in short sections supported from single points. By these eliminations the total damping of the structure would be reduced below that reasonably expected in the bridge and hence would be on the side of safety.

Second, simulation of natural airflow is impossible. Nothing is more changeable both in direction and velocity than the wind. Several readings of wind velocity and direction at the bridge site have been made and plotted. The curves invariably show a marked variation (increasing with the average velocity) of several miles per hour at intervals of a few seconds on either side of a median or average velocity. Since the changes in velocity are very rapid, they probably have less effect on the rate of impulse or vortex discharge, which sets the bridge in motion, than does the average velocity, which is also continuously changing.

In the wind tunnel wind velocity shows a similar tendency toward rapid changes either side of the average resulting from minor turbulence in the wind stream. However, the av-

erage velocity in the tunnel is constant for any given speed of the propellers.

It is impossible to simulate the random fluctuations of natural wind in working with the model. Not only is it mechanically impracticable to make such changes but the wind fluctuations are unknown. In consequence all tests are made with a constant average velocity throughout the test. A constant wind velocity feeds a constant amount of energy into the structure at a constant rate while a changing velocity feeds a changing amount of energy into the bridge at a changing rate. Thus the constant wind in the tunnel is more severe than the changing wind in nature.

Third, the angle of attack of the wind has a decided effect on stability. In all model tests the angle of attack is held constant over the full length of the bridge. The probability of this occurring over a length of 5,000 ft., the length of the bridge, is doubtful. Check tests on the model have shown that different angles of attack on various parts of the bridge have damping effect.

Tests on the model of the original bridge gave results which were in remarkably close coordination with those observed on the prototype except that amplitudes were greater and certain additional modes of motion were developed which had not been observed in the field. These additional effects are attributed to the more severe conditions, already mentioned, applied in the model tests.

Model of new bridge

Having thus established correlation between full models and prototypes, the next step in the investigation was to build up an areodynamic model of the proposed new design. This design was the same as that finally adopted except that it had a conventional floor slab.

This second model, again made on a scale of 50:1, was given the same careful attention in the endeavor to reduce damping to a minimum. In studying the effect of truss stiffness a device, consisting of small spring steel wires connected by movable clips to chord members in alternate panels, was developed by which the moment of inertia could be varied from about 1,900,000 in.^{4} to approximately 14,000,000 in.^{4} per truss by any desired steps.

Moments of inertia were determined in two ways. First by checking measured deflection under a given load with computed deflection and, second, by noting the period of vibration and substituting in the equation for computing vibration periods.

Tests on the model of the original bridge design confirming observations in the field, showed that structure to be primarily subject to purely vertical motion. This led to the opinion that vertical rather than torsional motion probably would be the predominant movement in the new design. Accordingly the model of that design was constructed primarily to study vertical movement. When tests were run it was found that contrary to expectation the new design was not subject to pure vertical motion at any stage of wind velocity or angle but was subject to torsional motion only.

Fortunately the model had been constructed with excessive torsional resistance in the top chord and floor systems (several times greater than that of the design). This made possible the later reduction of torsional resistance to that of the new design by splitting one side of the top chord by a longitudinal cut centered in the outer face of the square section that constitutes the top chord. In this way it was possible to test the effect of change in torsional stiffness as well as pure truss stiffness.

Results of model tests

Results of tests on this second model were as follows:

A. The full model proved to be completely stable for all velocities of wind from 0 to 120 mph. (the limit of the tunnel) and in vertical angles of attack from 2 deg. up and to 5 deg. down. Above 2 deg. it became unstable at 80 mph. and at 8 deg. up unstable at 50 mph. In this test the torsional stiffness was about the same as in the design and the moment of inertia of the trusses was set at 6,500,000 in.^{4} each (the I for the design is 6,850,000 in.^{4} per truss).

B. Increasing the I to 12,000,000 in.^{4} had very little effect. In fact, it decreased the critical angle (angle under which no motion exists for any

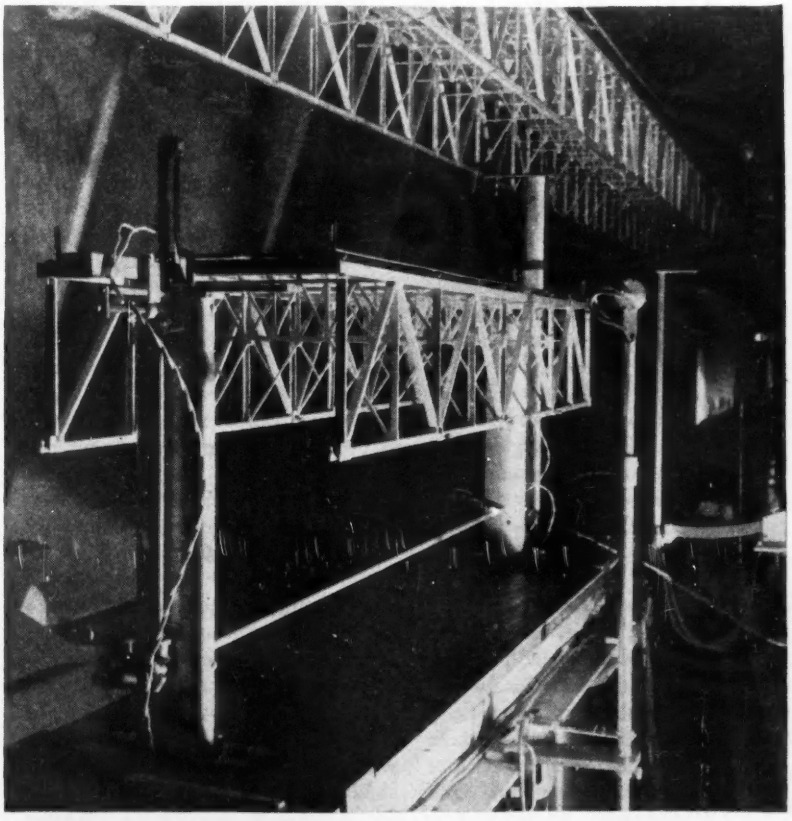

Fig. 3. Preliminary tests were made on short sections of various designs to save time and cost. Later the full-length model was used for confirmation.

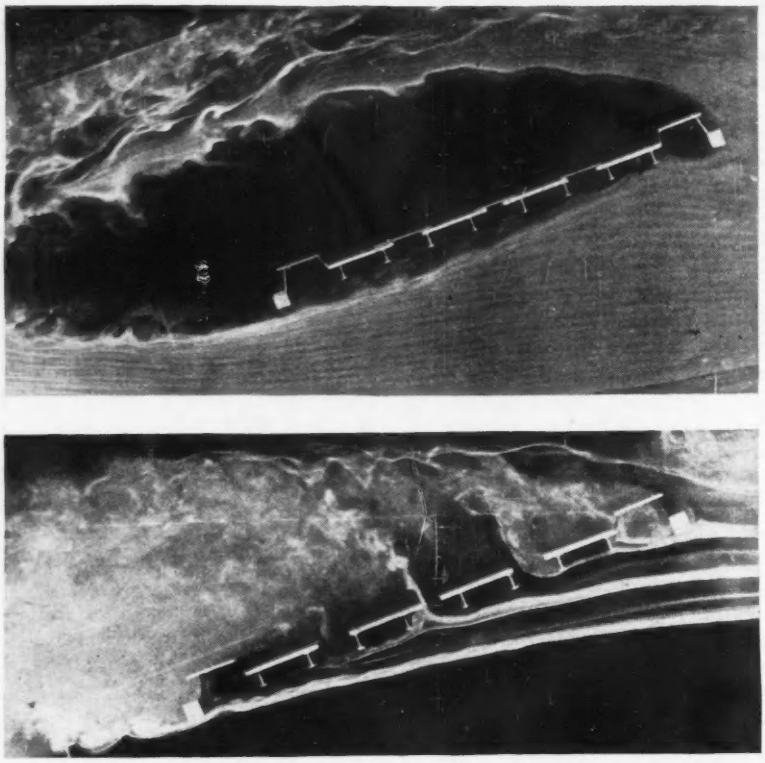

Fig. 4. Effect of roadway gratings is indicated by airflow (photographed with the aid of smoke) across solid floor (top), an unstable section showing a large vortex or disturbance in left upper corner; and across a floor with gratings (bottom), giving a stable section marked by smaller vortices whose disturbances are unimportant.

velocity up to 118 mph.) but displayed a different type of motion at less amplitude.

C. For a torsional stiffness several times greater than the design stiffness and estimated at about half way between the design stiffness and that which would be developed by the addition of a bottom lateral system, the critical angle of attack was increased to 5 deg. in an up wind with I equal 7,000,000 in.^{4} per truss. This test demonstrates that increase in torsional stability would be obtained by the use of a top and bottom lateral system.

D. The tests established certain critical angles of attack below which full stability was realized and no movement occurred. If the velocity was increased and the angle held constant or vice versa, motion would start and increase rapidly to amplitudes greatly in excess of those which could be permitted in the structure and to possible failure within probable wind velocities.

E. Smoke tests as well as tests on the former bridge model gave strong evidence that the prevailing winds at the site were horizontal or nearly so. In this case the preliminary design would probably be satisfactory because it was fully stable under such winds. However, such assumptions seemed somewhat dangerous. Storms of considerable intensity blow in from the southeast and in passing the bridge site approach a continuous high bluff on the westerly shore. There is a probability that the wind is deflected upward to pass over this bluff and in so doing might reach an upward angle of 5 or 6 deg. Thus upward angles might go beyond the demonstrated stability range.

F. The preliminary design had shown a great improvement insofar as stability was concerned over the original bridge but it was not yet considered safe. An acceptable design should prove stable in angles of attack of plus or minus 15 deg. in all wind velocities from 0 to 100 mph.

When results of the wind tunnel tests reached this stage it was apparent that two courses were open. Either (1) eliminate still further the cause of motion or (2) increase the ability of the structure to dissipate the energy being "fed in" by the wind.

Increasing the weight by 30 percent had proven ineffectual in the model of the original bridge. Likewise, increasing truss stiffness in the second model from 6,500,000 to 12,000,000 in.^{4} had not improved stability. A considerable increase in either or both of these properties would increase costs of the prototype beyond the desirable economic status of the project and would be likely to prevent its construction. It seemed logical, therefore, to attempt further to reduce the cause of motion.

Use of section models

In former studies it had been found that while section models (Fig. 3) could not be expected to correlate quantitatively with the full model they did give a fairly close indication of what the full model reactions would be. Their cost and the time required to build them were only a small part of what was required for the full model and hence a great many different forms or conditions could be tried out first in section models at a reasonable cost.

Tests in the wind tunnel on deck and sidewalk with all other parts of the structure removed proved that the disturbing forces originate principally in the deck. Impulses resulted from change in direction of airflow as it passed over the structure in the form of alternate vortex discharge, causing alternate variations of pressure on the deck surface. If these vortices could be reduced in size by breaking up large vortices into many small ones, the resultant total impulse might be reduced and the general turbulence increased. (Fig. 4).

Openings in floor effective

A section model was therefore tried in which roadway slots or open gratings were placed between each of the driving lanes and at the curbs. On the prototype these slots running the full length of the bridge will be made up of open steel grids bonded to reinforcing in the concrete slab of the driving lanes in such a way as to preserve full continuity of the slab as a whole over the stringers.

On section models various widths of open slots were investigated with results showing marked difference of stability, depending on the width of

slots. If the slots were too narrow beneficial effect was reduced. On the other hand, as the width was increased a point was reached beyond which there was no further benefit. After exhaustive tests on the section models the arrangement shown in Fig. 2 was selected and incorporated on the full length model. To date two groups of tests have been run; one with a stiffening truss whose moment of inertia, I, was 1,900,000 in.^{4} per truss and the other with an I of 7,200,000 in.^{4} per truss.

Summary of findings

The results of the long series of tests and studies may be summarized as follows:

1. Tests on the model built to simulate the original bridge and on that of the stiffening truss with a solid concrete floor, indicated that the results of certain winds would be "catastrophic," *i.e.*, motion always developed at critical wind velocities and certain vertical angles of attack. Beyond these points wind velocity increases built up the amplitudes so rapidly that failure of the model became imminent.

2. With the adopted design and an I of 1,900,000 in.^{4} per truss, vibrations occur only over a range of upward vertical angles of attack between 3 to 8 deg. and velocities from 24 to 38 mph. To build up the maximum amplitude wind must flow steadily for a period of 25 min. at a velocity of 30 mph. at a vertical angle of between 4 and 7 deg.

3. With an I of 7,200,000 in.^{4} per truss the results are similar except that the double amplitude is reduced to 1 deg.

These results are subject to the reservation that there is no definite knowledge of the damping characteristics of the prototype. The logarithmic decrements of the models are respectively 0.03 and 0.05 for inertias of 1,900,000 and 7,200,000 in.^{4} respectively.

It seems logical that open slots which permit air to flow through the deck largely cancel the fluctuating pressures and also increase turbulence. In model tests the effective impulses have been so reduced that the ability of the structure to dissipate energy is sufficient to balance the energy input from wind. Thus the work equation has been satisfied within a safe range of movement. The explanation of the improved behavior of a roadway in which there are open slots is illustrated by Fig. 4, showing results of a smoke test.

Since it is not possible to eliminate aerodynamic forces entirely, it follows that movement will occur. If the impulses are large, the work performed in a given time will be large and the ability of the structure to do negative work must also be equally great at small amplitudes if the maximum movement is to be held within satisfactory limits. On the other hand, if the impulses can be greatly reduced, then by the same degree will the required energy absorption within the structure be reduced and the predetermined limiting amplitudes will not be exceeded.

Investigations and tests on redesign of the Tacoma Narrows Bridge have been under the direction of a consulting board consisting of the writer as principal engineer and chairman of the board; Glenn B. Woodruff, San Francisco; John I. Parcel, Sverdrup & Parcel, St. Louis; and Dr. Theodor von Karman, California Institute of Technology. Dexter R. Smith is designing engineer, Prof. F. B. Farquharson, University of Washington, is in charge of model studies at the wind tunnel and George S. Vincent is resident engineer for the Public Roads Administration cooperating with the state of Washington in model studies. Jas. A. Davis is chief engineer of the Washington Toll Bridge Authority under whose jurisdiction the project is being carried out.

Brush Mat and Volcanic Cinders Used to Build Road Over Quagmire

Navy Seabees successfully used a brush mat and 24-in. covering of volcanic cinders to build a roadway over a two-mile quagmire on a Pacific island.

The project was a temporary road to facilitate building of a water supply line for a Marine camp. The first two miles of the road was readily located with the aid of a military clinometer and construction went forward rapidly over favorable, heavily-sodded mountain terrain, void of brush and timber.

At the end of the two-mile section, the road entered abruptly into a heavily-vegetated region of quagmire in which heavy equipment bogged down immediately after breaking through the surface crust of vegetation.

Six-foot testing rods penetrated the muck easily, but failed to reach solid bottom. The region is swept with rains or covered with a moisture-laden fog. The condition has resulted in a deep cumulose deposit of muck beneath the forest floor, permitting little sub-surface drainage. The ground surface was saturated with standing water.

The shortest and most direct route was across this area if a suitable method of construction could be found with the materials at hand. The corduroy type road could not be used because of a lack of suitable local timber.

Pierced steel-plank (airfield matting) was tried, but owing to the limited amount available only short sections of the road could be made stable with it. In some sections the steel plank was laid directly on the subgrade and surfaced with a 6-in. layer of volcanic cinders. In other sections, to prevent sinking of the plank, cinder-filled burlap bags were placed beneath the plank and the road surfaced with cinders.

The final and most successful method consisted of clearing the ground, by hand, without disturbing the sub-surface crust of vegetation and roots. By cutting adjacent brush and trees, a loose, hand-placed mat of this material was built up to a height varying from 2½ ft. to 3½ ft. and approximately 14 ft. wide. The brush mat was compacted by making several passes over it with a bulldozer.

Volcanic cinders, averaging 1½ in.-minus, were hauled and end-dumped directly on top of the brush mat, leveled off with dozer blades and further compacted to a final thickness of approximately 24 in.

A smooth-riding surface and thorough compaction was obtained by the flow of trucks over the road hauling cinders. No appreciable settlement has occurred to date.

Nicaragua Experiences

Big Dividends from a Malaria Campaign

Philip J. Coffey
Major, Sanitary Corps, and Sanitary Engineer
Office of Inter-American Affairs Field Party
Managua, Nicaragua

***Contents in Brief** — Following a severe malaria epidemic in Managua late in 1942, the Nicaraguan government was assisted by the U. S. Office of Inter-American Affairs in the establishment of control measures. The efforts of this cooperative health service, which included the installation of permanent drainage facilities, resulted in a 76-percent reduction of malaria incidence. The entire cost of the program was only slightly more than one year's economic loss to the community from this disease.*

AN EXPENDITURE of $100,000 for malaria control measures, of which $87,000 represents the cost of permanent drainage works, in one year reduced the incidence of this disease by 76 percent in Managua, capital city of Nicaragua. Evaluated on another basis, the entire cost of the program, most of which included facilities with an expected life of 20 yr., was only slightly greater than the estimated annual economic loss suffered by the community from the ravages of malaria.

In brief, these are the gratifying conclusions to be reached following an anti-malarial campaign that was instituted by the health and sanitation division of the Office of Inter-American Affairs in cooperation with the Nicaraguan national health department. Managua, the locale of the program, is a city of 76,000 population, and it is the least favorably situated of the five Central American capitals with respect to climate and sources of the mosquito-borne malaria scourge. Only 180 ft. above sea level, its climate is hot the year around. The city has a three-mile waterfront on Lake Managua, a broad, shallow body of fresh water with gently-sloping beaches in the vicinity of the capital. The lake has a mean elevation of about 130 ft. above sea level, but varies over long cycles of years by more than 20 ft., depending on the rainfall. During cycles of sub-normal rainfall the water recedes, leaving a marshy beach several hundred feet wide.

The malaria vector *Anopheles albimanus* finds an ideal habitat in pools left by the recession of the lake, and in tracts of spring-fed marshes along the easterly shore of the city. Profuse mosquito-breeding occurs also in the numerous abandoned quarry-holes, borrow-pits and laundry cisterns along the shore, as well as in depressions and gullies scoured out by flow from the municipal storm-sewers, which end at the high-water line.

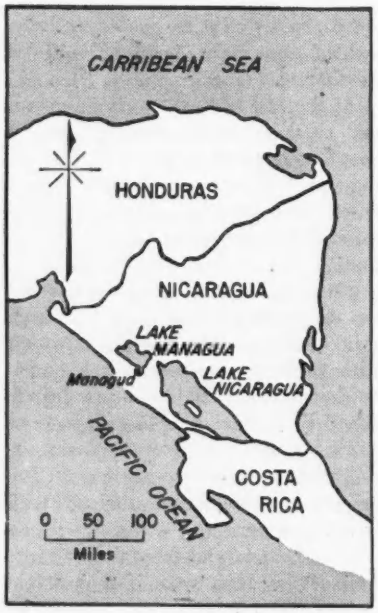

Fig. 1. Location map of Managua and the lake adjacent to it.

Poor general sanitation is also a factor in dissemination of malaria. According to a survey made in August 1943, only 1.4 percent of all dwellings are properly screened, 37 percent have no water service, and 58 percent lack sanitary sewer connections. Only about one-third of the streets are paved and drained by storm sewers. Two fortunate circumstances reduce the danger of such defects in sanitation: Good natural drainage toward the lake, which removes most surface water rapidly, and the natural habits of *Anopheles albimanus*, which rarely develops in artificial water containers.

One of every three infected

In November, 1942, a survey was made to determine the prevalence of malaria in the city. Blood smears from 200 persons in each of nine districts were examined microscopically for the presence of malaria parasites. Nearly one-third (33.03 percent) of all persons examined were found to be harboring the organisms in their blood. As was expected, the highest rates of infection were found in the low, poorly drained eastern sections. In one district, Barrio Silva, an infection rate of 70.5 percent was encountered. Much lower rates prevailed in the higher, better drained south and southwest wards.

Between September, 1942 and January, 1943, a comprehensive plan was developed for combating mal-

aria in the city. A short-term project was established for treatment of the worst mosquito breeding areas with larvicides, pending the planning and execution of permanent drainage works. Finally, it was decided to materially strengthen the malaria control activities of the division of sanitary inspection of the National Health Department.

The larvicidal work was begun September 22, 1942, and was planned to continue until December 15, or about two weeks beyond the close of the normal May-November rainy season. Unusually late rains led to a decision to reopen the project for at least a two-week period beginning December 28.

Knapsack-type sprayers used

Diesel oil was the larvicide used. Crews of oilers and brush-cutters were organized to traverse the five-mile strip of coast within and contiguous to the city, as well as certain poorly drained areas adjacent to the Taca airport in eastern Managua. Oil was applied with knapsack-type sprayers. No fixed stations were established for distribution of oil as it was believed cheaper and more satisfactory, for the short period of the work, to haul it to the point of use in the native bullock-carts.

Results of this initial project were disappointing. Although the work was carried out conscientiously and oil distribution exceeded 500 gal. per week, the malaria rate was not appreciably diminished during the critical season. Apparently many breeding places were not discovered, or else this approach to the problem was in itself inadequate.

Drainage and fill projects

In the meantime, however, preliminary engineering studies had been completed and work started upon two large-scale projects for drainage and fill. These were the so-called Cauce Oriental and Lake Shore Drainage projects.

The idea of a Cauce Oriental, or eastern flood diversion canal, was originated some years ago by Estus H. Magoon, noted sanitary engineer of the International Health Division of the Rockefeller Foundation. The topography of eastern and southeastern Managua is such that during the rainy season it receives a large part of the torrential runoff of the slope from the highlands of the western cordillera to Lake Managua. The waters enter the city chiefly through radiating suburban roads which have become so deeply eroded in many sections as to resemble canals rather than highways.

Work upon the canal was begun

Fig. 2. Groundwater drainage ditch on the shore of Lake Managua. Lateral subsoil drains are connected to the ditch, which is lined with Panama-type precast concrete inverts. Note the spring in the foreground, which will be drained by the ditch.

Fig. 3. Diesel oil was used for larvicidal spraying in the areas adjacent to the lake shore prior to the installation of drainage works. Results from these efforts were said to be disappointing, despite distribution of more than 500 gal. of oil weekly. The malaria rate was not appreciably diminished.

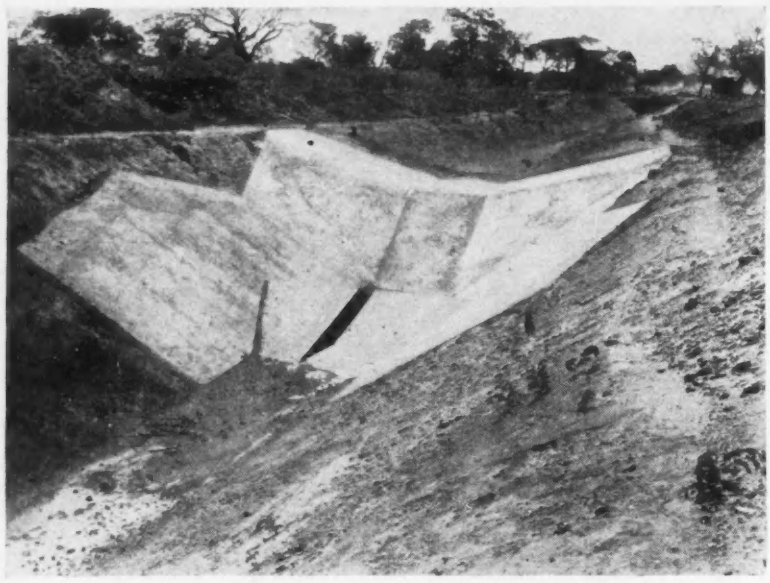

Fig. 4. Concrete "drops" of this type were built at intervals in the 13,800-ft. long drainage canal to moderate flow velocities and check erosion. The slotted sill at the foot of the drop minimizes scouring at the downstream edge of the apron.

in November, 1942, and completed in August of the following year. Hand labor was used for the greater part of the work owing to the scarcity of excavating and earth-moving machinery. The main canal is 13,800 ft. long, including 1,800 ft. paved with brick or concrete masonry, and has a hydraulic capacity of 1,050 sec.-ft. in its lower portion. Side slopes are 1½:1 and bottom widths vary from 3 to 6 ft.

Concrete "drops" moderate flow

An interesting construction feature is the use of 19 massive concrete drops, 4 to 12 ft. in height, along the course of the channel. These drops permit a reduction of the channel grade to 0.4 percent, thereby moderating flow velocities and checking erosion. Slotted concrete sills were constructed at the foot of each drop to reduce erosion below the downstream edge of the paved apron, and they fulfilled this purpose well.

Excavated material was deposited in neatly trimmed spoil banks along the canal, or used for filling nearby depressions. Where spoil banks were formed openings were cut through at 100-ft. intervals to admit surface runoff to the canal. The entire job involved 66,500 cu. yd. of excavation, placement of 1,162 cu. yd. of masonry and 1,201 sq. yd. of mortared-rubble paving, and the construction of six culverts and small bridges.

In the Lake Shore drainage project, the problem of permanent control was attacked in three ways: (1) by providing adequate drainage for the groundwater, through subsoil pipe drains discharging into paved outlet canals; (2) by prolonging the storm-sewer outlets of the city in paved channels extending to the water's edge; and (3) by the filling of numerous areas lying too low for drainage.

Before undertaking this work, however, it was necessary to establish a shop for the manufacture of a large quantity of drain pipe and ditch-lining sections. A few steel molds and one pipe-making machine left from earlier activities of the Rockefeller Foundation were available, but for the most part it was necessary to improvise forms from lumber and concrete because of the scarcity of suitable sheet steel. The inverts were of the well-known Panama type, 30 in. long and 14 in. inside diameter, cast horizontally in molds of steel, wood and concrete; liner plates were cast in vertical gang-molds producing 46 plates in each batch.

Drainage work details

The drainage project was begun during the latter part of December, 1942, and finished the following November. It comprised 54 paved and two unpaved drainage ditches, 3 to 15 ft. wide, and distributed along four miles of lake shore within and contiguous to the city, their aggregate length is about 13,500 ft. A network of lateral 4- and 6-in. pipe drains, totaling 10,071 ft. in length, discharge into these outlet channels.

Placement of earth fill in natural and artificial depressions along the shore, totalling 8,700 cu. yd. was retarded by lack of earth-moving machinery; the only equipment available was a few small ox-drawn farmers' scoops, wheelbarrows and the native bullock-carts.

In March, 1943, a third project was begun, repair and improvement of an old drainage ditch, the so-called "Cauce Occidental" on the west side of Managua. The work comprised chiefly cleaning, channel rectification and grade adjustment of this 11,000-ft. canal, rebuilding of inadequate culverts, and excavation and paving of a new outlet to Lake Managua. It was completed in June, 1943.

Other control measures

Arrangements were made for the distribution of anti-malarial drugs, consisting of large numbers of atabrine tablets and lesser quantities of atabrine dihydrochloride powder, plasmochine, totaquine and quinine. These drugs were sold at actual cost plus 10 percent for administrative expenses involved in distribution. The resulting price was about one-twentieth of the previous market price. The project was financed on a revolving fund basis, receipts from sales being applied for purchase of additional drugs.

As a final measure in the anti-malaria campaign, the National Health Department was enabled, by means of a grant from the United States to employ twenty additional sanitary inspectors and a graduate public health engineer to direct their work. The new men were given an intensive "short course", lasting three weeks, to train them in the fundamentals of environmental sanitation, with especial emphasis on malaria control. Their training was continued after appointment by means of periodic classes and conferences.

Following their appointment the majority of the new inspectors were assigned to make a city-wide house-to-house sanitary survey. This resulted in the discovery and elimina-

tion of a large number of hitherto unknown mosquito breeding places in occupied premises. Most species encountered, to be sure, were culicines and aedines (including *A. aegypti*, the vector of yellow fever and dengue) rather than anophelines, but the survey had the further value of acquainting the public with the role of the mosquito in disease transmission.

Education of the public was a strongly emphasized phase of the inspector's work. They were instructed to give a simple explanation of the role of the mosquito in the transmission of malaria and other diseases, to point out to the householder the actual breeding places on his premises, to give specific directions for elimination of such sources, and then, in the course of follow-up visits, to see that the instructions were carried out.

In December, 1943, following the completion of all of the permanent control measures described, another parasitic index survey was made in Managua. This survey covered the same districts as in November, 1942, and involved examination of an equal number of blood specimens. The comparative results were as follows:

District	Percent of Specimens Nov. 1942	Blood Infected Dec. 1943
Barrio Silva	70.5	10.5
Barrio Estrade	51.5	14.5
Barrio Larreynaga	48.5	13.5
Barrio de la Cruz	34.2	6.5
Calle Trixione	15	5.5
Colon	22	7
Barrio de la Perla	13	8
Barrio Sajonia	16	2.5
Campo Bruce	26.6	2.5
Average	33.0	7.8

Overall Average Reduction 76.4%

Additional surveys are being made from time to time. The latest, which covered five of the nine districts, was made in March and April 1944. At that time a further reduction, to an average of 5 percent infected specimens, was indicated in the five districts of Silva (3 percent), Estrade (6 percent), La Cruz (8 percent), La Perla (3 percent), and Campo Bruce (5 percent).

Economic evaluation

A brief examination of the economic aspects of this program should be of interest to municipal officials and public health workers.

From an inspection of the statistics cited in this article, and assuming that the surveys gave approximately correct information with respect to the general malaria rate throughout the city, it would appear that the reduction in the number of cases between November, 1942, and December, 1943, was 19,200. If half of these are wage-earners with an average income of $1.00 per day, their loss of time for six days annually in two attacks of the disease costs the community $57,600 each year.

The average cost of treatment, including drugs, can hardly be less than $1.00 per case even when the drugs are distributed at cost and a certain proportion of the treatment is given at public clinics. This represents an additional economic loss of $38,400.

The annual economic loss to the community, as a result of these 38,400 attacks of malaria, therefore, may be conservatively estimated at $96,000.

The cost of the entire malaria control campaign in the city for the 12-month period ending December, 1943, was about $100,000. This figure, however, includes $87,000 worth of so-called permanent drainage works which have an expected life of at least twenty years. The annual cost of continuing the program, including maintenance of the drainage works, a reasonable allowance for their depreciation, maintenance of the activities of the Division of Sanitary Inspection, and a larvicidal project during the rainy season, should not exceed a total of $15,000 a year, according to best possible estimates.

If it be conceded that the anti-malarial campaign was responsible for the reduction in the malaria rate, it would appear that the economic saving nearly repaid the entire cost of the program, including the permanent works, in the first year. If this reduction can be maintained in succeeding years the saving in wage losses and cost of treatment will far outweigh the cost of preventive measures.

Fig. 5. Precast concrete inverts stacked in the storage yard. A total of 18,000 ft. of inverts and 24,000 ft. of flat liners were cast here and used for the paving of drainage ditches. Permanent drainage facilities have an expected twenty-year life.

Direction of the project

The Cooperative Public Health Service in Nicaragua is one of the organizations operated in eighteen Latin-American republics by the Health and Sanitation Division of the Office of Inter-American Affairs.

C. I. Sterling is chief engineer of the division. American field representatives in Nicaragua are Capt. Leonard S. Rosenfeld, M. C., director of the service, and Maj. Philip J. Coffey, Sn. C., sanitary engineer.

Among the many Nicaraguan officials who contributed to the success of the program, special recognition is due Col. Luis Manual Debayle, director-general of the National Health Department, Dr. M. A. Sanchez-Vigil, director of the National Institute of Hygiene, and Manuel I. Lacayo, chief engineer of the Cooperative Public Health Service.

Tests of Compacted Clay Soils Provide Highway Design Guides

Henry C. Porter
Research Engineer
State Highway Department, Austin, Texas

***Contents in Brief**—Corroborative laboratory tests modify conclusions reached in preliminary tests recorded in Enginering News-Record Aug. 23, vol. p. 245. The additional tests show that there are definite limits to reduction of water content and increase in compacting force beyond which the compressive strength of clay soils does not increase but instead positively decreases. Use of laboratory tests of actual project soils for roadway design is described.*

COMPRESSION TESTS of a selected clay soil (S-1) described in *Engineering News-Record*, Aug. 23, 1945, showed that with certain combinations of moisture content and compaction force applied, a clay soil can be made to carry large compressive loads without structure rupture, but if the compacted soil subsequently becomes saturated with water a very large percentage of its strength will be lost. The conclusions to be drawn from these findings and the practical application of the findings to actual construction were discussed.

To confirm the original tests on Soil-1 (S-1, see Fig. 2) and to determine whether the general effects of water content and compacting force combinations are the same on other clay types, tests have been continued on Soil-1, and extended to include two other clay soils (S-II and S-III, see Fig. 2). Since the trend of plotted data (see Fig. 2) is the same for all three soils tested it is assumed, for the present, that they are representative of all clay soils. It is to be noted also that these supplementary tests were made only on test cylinders immediately after molding. No tests are included of cylinders after subsequent saturation. These tests then corresponded in procedure to the Series A tests described in *Engineering News-Record* of Aug. 23, 1945.

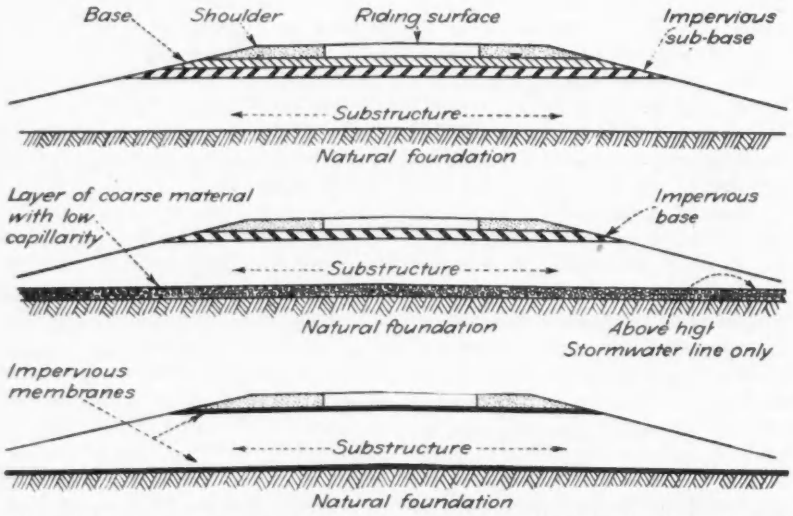

Fig. 1. Methods of preventing detrimental moisture-content rise in clay soil road substructures from gravity rain water and capillary ground water.

The Series A tests, as reported, indicated that the lower the soil moisture content and the greater the compacting force applied the greater is the compressive strength. The extended tests described here show that there is a limit to each of these factors. (1) When the moisture content decreases below a certain amount the compressive strength decreases, and (2) when the compacting force increases beyond a certain amount, *optimum* for each water content, the compressive strength decreases. These findings are developed later.

The tests of Soils I and II, as recorded, are not complete. It appears however, that the results, as given on graphs Figs. 2, S-I and S-II indicate trends so clearly that release of the information for immediate use is warranted as an aid to postwar planning. The tests on Soil III are substantially completed, as shown by the accompanying table and the graphs, Fig. 2. The table indicates the plan of testing and the results obtained. Note the similarity of the curves, as shown by Fig. 2 for all three soils.

The moisture contents at which the Soil III tests were made, ranged from a maximum near the generally termed "optimum for maximum density with 75 rammer blows" down to near the moisture at which further decrease caused a decrease in compressive strength. The number of rammer blows or "units of compaction" applied varied from 75 to that beyond which a decrease in compressive strength is caused, or to beyond the point where the moisture-content compaction-force compressive-strength graph turns to or toward the horizontal direction, (see Fig. 2).

The test results show that a com-

pacting force equal to only 75 rammer blows produces comparatively little compressive strength in the soil regardless of the moisture content—58 psi. was the maximum in the three clays. A maximum of 210 psi. was obtained with less moisture and a greater compacting force, Fig. 2. There is a limit, however, to decreasing moisture content and to increasing compacting force. A point in reduction of moisture content is reached where further reduction causes loss of strength. This is the *optimum* moisture content for *ultimate* maximum compressive strength in the soil. Also, in increasing the compacting force a point is reached where further increase ruptures or tends to rupture the soil structure.

This is the *optimum* compacting force for *ultimate* maximum compressive strength; and the two together make the *optimum combination* of moisture content and compacting force for ultimate compressive strength in the soil.

The graph, Fig. 2, S-III, shows that where the soil-moisture content is very high, the optimum compacting force for maximum strength is relatively low. It appears that 75 units of compaction produced the maximum compressive strength when the moisture content was 37 percent in the S-III soil while 225 units produced the maximum when the moisture content was 34 percent, and 350 units produced the maximum when the moisture content was 30 percent. With these high moisture contents, the application of additional force above the optimum caused an immediate decrease in compressive strength. The direction of the graphs turns down decidedly. The optimum compacting forces for maximum compressive strengths in this clay soil with moisture content of 37, 34, and 30 percent, therefore, are 75, 225, and 350 units of compaction, respectively.

These are not the results when the moisture contents are 27 percent or lower. The 27 percent moisture graph (Fig. 2, S-III) turns nearly horizontal between 325 and 375 units of compaction and then resumes an upward direction between the 425 and the 525 units. The decided breaks in upward direction of the graphs of test specimens, with soil moisture below 26 percent, are near the 375 units-of-compaction point. This phenomena indicate that ramming or rolling beyond the optimum amount breaks or tends to break the soil structure. These data indicate, however, that if ramming is continued, eventually an integral structure is *re-created* in the soil.

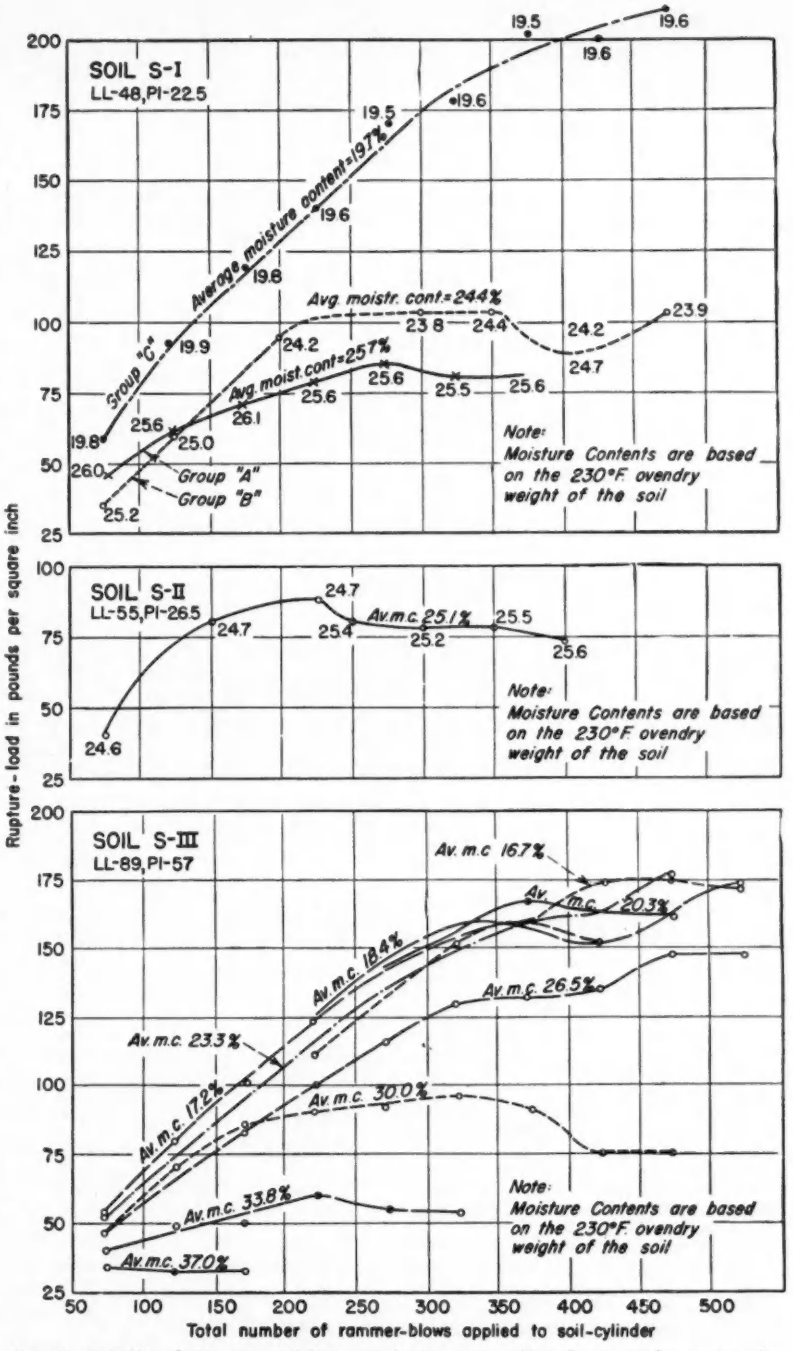
SOIL S-I
LL-48, PI-22.5
Average moisture content=19.7%
Avg. moistr. cont.=24.4%
Avg. moist. cont=25.7%
Group "C"
Group "A"
Group "B"
Note: Moisture Contents are based on the 230°F. ovendry weight of the soil
SOIL S-II
LL-55, PI-26.5
Av.m.c. 25.1%
Note: Moisture Contents are based on the 230°F. ovendry weight of the soil
SOIL S-III
LL-89, PI-57
Av. m.c 16.7%
Av. m.c. 20.3%
Av. m.c. 18.4%
Av. m.c. 26.5%
Av. m.c. 23.3%
Av. m.c. 17.2%
Av. m.c. 30.0%
Av. m.c. 33.8%
Av. m.c. 37.0%
Note: Moisture Contents are based on the 230°F. ovendry weight of the soil
Rupture-load in pounds per square inch
Total number of rammer-blows applied to soil-cylinder

Fig. 2. Relation between moisture content, compaction force and compressive strength of three clay soils tested immediately after compaction.

1. Practicable laboratory tests can be made and moisture-content, compaction-force, compressive-strength graphs drawn that will show the amounts of compaction force required—the optimum amounts—to produce maximum strength in a clay soil with various water contents. After a graph chart is prepared (see Fig. 2, S-III) it will be necessary only to

determine the natural moisture contents during construction to learn the compaction force necessary to produce maximum compressive strength. The chart will also show the different combinations that will produce the same compressive strength.

DATA ON CLAY SOIL (S-III) TEST-CYLINDERS COMPACTED WITH DIFFERENT MOISTURE-CONTENT COMPACTION-FORCE COMBINATIONS AND IMMEDIATELY LOADED TO RUPTURE

Test-cyldr. No.	Moisture content when molded and loaded to rupture, in percent	Average moisture content in percent, each set of cylinders	Total rammer blows applied to soil cylinder	Soil density when removed from mold and ruptured, in lb. per cu. ft.	Relative rupture load, in lb. per sq. in.	Vertical deformation of cylinder when ruptured, in inches
A-1	37.0		75	80.1	33.4	0.36
-2	37.1		125	81.9	32.6	0.40
-3	36.9	37.0	175	82.4	32.6	0.40
B-1	34.1		75	80.2	39.0	0.37
-2	34.0		125	84.4	47.7	0.46
-3	34.3		175	85.1	49.3	0.46
-4	33.2		225	86.6	59.7	0.30
-5	34.0		275	85.9	55.7	0.34
-6	33.3	33.8	325	86.8	53.7	0.33
C-1	30.7		75	81.1	45.8	0.19
-2	29.6		125	85.7	70.0	0.41
-3	29.5		175	88.9	85.1	0.40
-4	29.4		225	90.6	89.9	0.40
-5	29.9		275	90.8	91.5	0.26
-6	29.4		325	91.6	95.5	0.33
-7	30.0		375	91.4	91.5	0.30
-8	30.8		425	90.0	75.6	0.28
-9	30.6	30.0	475	90.3	75.6	0.30
D-1	26.2		75	78.2	45.8	0.08
-3	27.3		175	87.5	83.6	0.27
-4	27.4		225	90.7	99.5	0.36
-5	26.9		275	93.3	111.8	0.35
-6	26.5		325	94.2	129.3	0.27
-7	26.3		375	94.7	131.3	0.25
-8	26.3		425	95.1	135.3	0.30
-9	25.8		475	95.8	147.2	0.23
-10	25.8	26.5	525	96.0	147.2	0.25
E-1	23.5		75	79.5	52.5	0.10
-4	23.5		225	92.4	121.4	0.23
-5	23.1		275	94.6	137.3	0.29
-6	23.4		325	95.5	147.2	0.30
-7	23.1		375	96.4	159.2	0.13
-8	23.2		425	96.3	163.1	0.20
-9	23.5	23.3	475	97.2	177.1	0.20
F-5	19.8		275	93.4	143.2	0.10
-7	20.5		375	95.6	167.1	0.09
-8	20.5		425	95.0	163.1	0.09
-9	20.3	20.3	475	95.2	161.1	0.14
G-4	18.4		225	91.6	129.7	0.08
-5	18.2		275	93.8	144.4	0.08
-6	18.5		325	94.5	159.1	0.07
-7	18.6		375	95.8	157.1	0.10
-8	18.3		425	94.8	151.2	0.06
-9	18.2		475	96.0	163.1	0.08
-10	18.3	18.4	525	96.2	173.1	0.08
H-1	17.4		75	84.2	53.7	0.07
-2	17.2		125	86.0	79.6	0.07
-3	17.6		175	89.6	100.4	0.06
-4	17.1		225	93.0	123.3	0.08
-5	17.1		275	94.4	143.2	0.06
-6	17.0		325	95.7	147.2	0.06
-7	17.1		375	96.2	159.2	0.07
-8	17.4	17.2	425	96.1	151.2	0.06
I-4	16.6		225	91.9	111.4	0.08
-6	16.8		325	95.7	151.2	0.07
-7	16.8		375	96.2	159.1	0.07
-8	16.6		425	97.7	175.1	0.06
-9	16.7		475	98.2	175.1	0.06
-10	16.8	16.7	525	97.8	171.1	0.04

2. Application of compacting force in excess of the optimum for such moisture content should be avoided and the compacted soil should be protected from excessive loading.

3. The compacting force may be regulated to produce the maximum compressive strength for each existing natural water content found along the route, in which case the superstructure design may be changed to fit the different compressive strengths or the same design, having different factors of safety, the least of which should be ample, may be used throughout.

4. The compacting force may be regulated to produce a uniform compressive strength throughout all, or a section of the route, in which case the same superstructure design, with a uniform safety factor, may be used throughout the route.

5. In some instances the natural soil moisture content will be so great that the maximum compressive strength when compacted will be considerably below the unit weight of maximum traffic loads. Also, in some instances, it may be impracticable to prevent appreciable subsequent increase in the soil moisture content. In those cases the superstructure must be designed with sufficient beam-strength to spread maximum traffic loads over large enough areas of substructures so none of the soil will ever be loaded enough to break its structure.

6. Subsequent continuous protection of the compacted clay soil from moisture content fluctuations and overloading sufficient to rupture the soil structure is sufficiently important for reiteration. Where seep-water prevails or is liable to occur subsequent to the completion of the roadway or runway, provision should be made during construction to intercept that water as far away from the substructure as practicable by surface drains, subdrains, or both.

Suggestions for preventing detrimental moisture content rise in clay soil substructures, from rain-water and from capillary ground-water, are illustrated in Fig. 1. When coarse-grained capillary-rise breaks are used, as illustrated in the upper cross-sections, provision should be made for preventing the coarse grained material from becoming contaminated with impervious clay soil.

Fig. 1. Walls of the Philippine hospitals are built of pre-assembled 8-ft. sections, which permit rapid erection.

Pacific Hospitals Built of Sheet Steel

***Contents in Brief:** — Designed in 8-ft. linear modules, numerous one-story Army hospitals built in the Pacific area have a framework of sheet steel formed to structural shapes and an exterior covering of 2-ft. wide panels of sheet metal. Floors are built of plywood, and sidewalls and ceiling are lined with wallboard. Use of 8-ft. module permits variations in length of building and spacing of doors and windows.*

AT SEVERAL LOCATIONS in the Pacific area large one-story hospitals have been built in accordance with a special all-bolted sheet metal design developed for the tropics. In the Philippines alone, ten 1,000-bed hospitals are under construction. Barracks, warehouses and other one-story structures are also expected to be built based upon the new design, which is termed prefabricated and utilizes an 8-ft. linear module.

In preparing the design a primary object was to employ materials that could be readily packaged to keep shipping space requirements to a minimum. This restriction was made in view of the fact that supplies for building hospitals were to be delivered soon after the first invasion troops landed. The designers also were instructed to eliminate the use of lumber, as this material at that time was critically short in comparison with the supply of strip and sheet metal. In addition, from the standpoint of shipping weight the preferred building width did not lend itself to the economical use of a framework of structural steel shapes, which also were in short supply.

As a result, the adopted design calls for a framework of sheet steel formed to structural shapes, and an exterior covering of 2-ft. wide panels of 24-gage sheet metal, factory-punched to permit rapid assembly. The floor is $\frac{1}{2}$-in. plywood, and the interior wall finish is $\frac{3}{8}$-in. insulating wallboard.

To cope with tropical conditions the following considerations were included: Support of the building a few feet above the ground, a 2-ft. projection of the eaves, louvers at floor level at each side, an almost continuous band of windows along both sidewalls, and a continuous ridge ventilator. The latter three features provide excellent ventilation and good day lighting provisions.

Design offers many advantages

Construction of this type of building, which is designed for a 15-lb. wind load and 70-lb. live floor load, is said to result in a number of advantages in addition to low shipping cubage and weight. These added advantages include: (1) rapid straight-

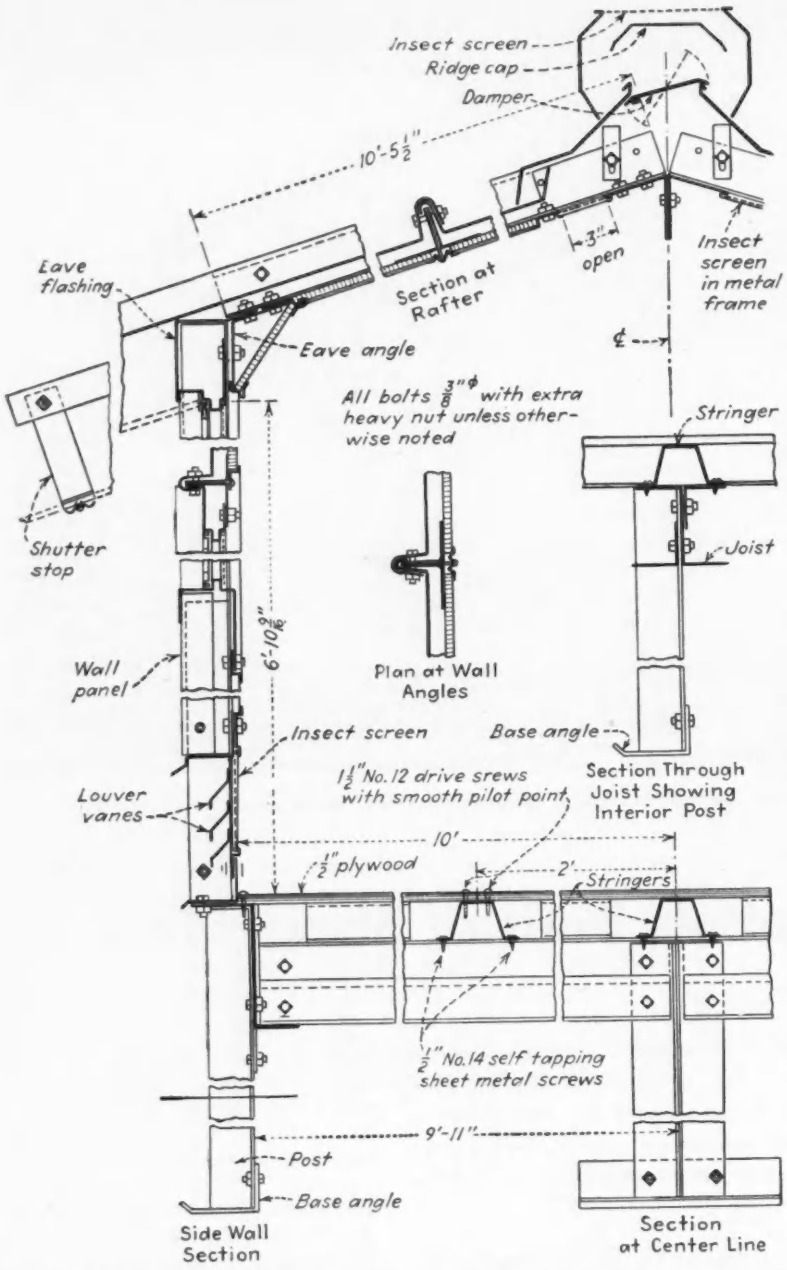

Fig. 2. The frame of the building is made up of members fabricated from strip and sheet metal. The plywood flooring and the sidewall insulation are secured in place with drive screws. Basic building is 20 x 48 ft.

forward erection without the use of cranes or other lifting equipment; (2) native labor can be used for the erection work; (3) the design permits disassembly of a building and re-erection elsewhere; (4) the structure is termite-proof and is expected to have a relatively longer life under tropical conditions than timber construction; and (5) the building can be requisitioned from depot stocks like most other items of military issue.

The basic building measures 20 x 48 ft., and requires less than 8 tons of materials that take up only 272 cu. ft. of shipping space. But since the standard layout calls for repetative use of the 8-ft. linear module, buildings of any multiple of this length can be constructed by insertion of extra sections. Moreover, by use of door and window sections, all designed to the 8-ft. module plan, openings can be provided at any point along the sidewalls and the number of windows can be varied to suit local conditions.

Design has versatility

In constructing a 1,000-bed hospital more than 100 one-story buildings of many different lengths are required. Dispersed over a large area, all of these structures are generally joined by covered walks. Versatility of the basic 8-ft. module is proven by the fact that all of these buildings with the exception of the laundry and one or two other structures are built to the basic design.

Construction of a typical 20 x 120-ft. ward building is shown in the accompanying illustrations. To reduce trouble from insects and minimize dampness, the floor of the building is placed about 3 ft. above the ground. The foundations consist of posts spaced on 4-ft. centers longitudinally and 10 ft. transversely, a single row of interior posts being used on the centerline of the structure. The corner posts are made up of three 2¾ x 2¾-in., 16-gage angles 4 ft. long bolted together. All other posts are double angles. Each post is supported on a 1-ft. long base angle of the same weight as those used for the posts.

Longitudinal girders at the base of the outer walls are 18-gage, 7¼-in. deep Z sections delivered in 8-... lengths. The transverse joists, which are on 4-ft. centers, are I-beam shaped members made up of two angles bolted to a 5-in. Z. The stringers are on 2-ft. centers and consist of 18-gage U-shaped sections 2¾ in. deep.

Spaced on 2-ft. centers, all of the sidewall posts are two 2¾ x 2¾-in. angles bolted back-to-back with the stem of the resulting T-section placed on the exterior side of the wall. This arrangement permits the 2-ft. wide sheet metal enclosure panels, which are delivered with a crimp along the vertical edges, to be fitted over and bolted to the stem of the posts. At the same time a flat bearing surface is provided for the insulating board.

The roof construction is similar to the sidewalls, consisting of double-angle rafters on 2-ft. centers to which the sheet metal panels are bolted. At the eaves the rafters rest on a bent plate attached to the top of the wall, and at the ridge of the roof they are bolted to two special longitudinal angles. Horizontal ties made up of a

pair of angles are added on 8-ft. centers to take the thrust of the roof, while a single longitudinal angle is used at the mid-point of the ties to increase the longitudinal stiffness of the building.

Walls erected in 8-ft. lengths

Most satisfactory erection technique developed in the Philippines has been to construct the building on an assembly-line basis. For example, the walls are assembled in 8-ft. panels on the ground and then lifted into place by hand (Fig. 1). This procedure minimizes the work to be done from scaffolding.

The plywood flooring is added after the building has been inclosed. In this work self-tapping drive screws are used to anchor the 4 x 10-ft. precut panels in place (Fig. 2). The screws readily penetrate the sheet metal, but must be turned out to be removed, as to pull them is difficult. It is to be noted that U-shaped channel fillers of the same weight and depth as the stringers are added above the joists to provide bearing along all four edges of the plywood panels.

The 2-ft. wide wallboard panels used on the sidewalls and ceiling are secured in place with narrow metal strips and drive screws similar to those used in the floor. The wall screws are driven between the two angles used as a column (Fig. 2). Like the floor screws, they may be removed with a screw driver but are exceedingly hard to pull. Experience to date shows this method of attaching the panels to be satisfactory.

Local labor is being used to construct the building illustrated. Although these men had little past experience on construction, those in charge report satisfactory progress. In fact, use of the building unit in the Philippines and elsewhere is proving so successful that similar buildings designed for temperate climates are to be built in Japan. It is interesting to note that some of the units already built have withstood a 65-mph. wind.

The designs were prepared by the Office of the Chief of Engineers under the direction of Col. Robert A. Lewis, head of the planning branch, plans and training division, and Col. L. C. Urquhart, chief of the engineering division, military construction. The pilot designs were tested at Ft. Belvoir, Va.

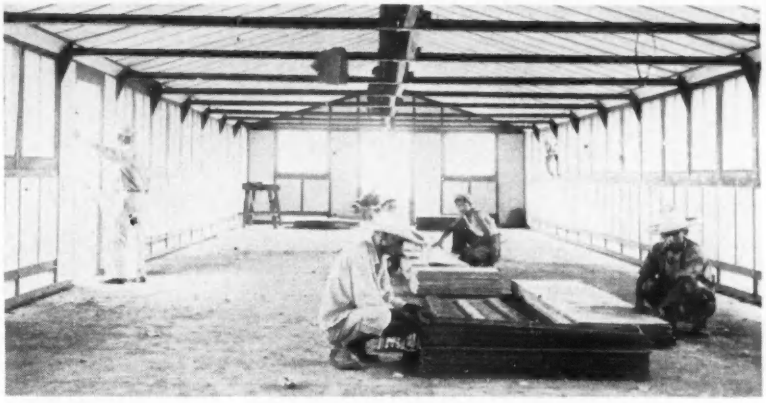

Fig. 3. Wallboard insulation results in wall of neat appearance, while continuous bands of windows provide good lighting and permit ventilation. Louvers at base of walls also aid ventilation.

Fig. 4. Spaced on 4-ft. centers, the floor joists are built-up members shaped like I-beams and the stringers are U-shaped sections on a 2-ft. spacing. Short filler sections similar to the stringers are added on top of the joists.

Fig. 5. Last operation in construction of the roof is installation of a continuous ridge ventilator. Roof consists of double-angle rafters spaced 2 ft. on centers to which sheet metal panels are bolted.

Fig. 1. Example of erosion by surface runoff shown by washout of a shoulder gutter in a heavy thunderstorm at the Jacksonville, Fla., airfield.

Shoulder Gutters Check Airfield Erosion

Harold A. Scott
Head, Hydraulics Section, U. S. Engineer Office, Jacksonville, Fla.

***Contents in Brief**—Erosion by storm runoff endangered runways at Jacksonville, Fla., airfield. Wide gutters, discharging to catch basins or spillways, were constructed at edges of the shoulders. Surveys show no erosion since gutters have been in operation despite 1¼ in. of rainfall in 15 min., nearly 3 in. in an hour and 9¼ in. in 24 hr.*

A SYSTEM of shoulder gutters, with adequate inlets and spillways, is now solving a difficult problem of erosion at the Jacksonville, Fla., airfield. As erosion is a common trouble in southeastern airfield development, particularly during construction and before a grass cover can be grown, the successful experience with simple surface drains at Jacksonville is of interest.

In 1941 the Jacksonville municipal airfield No. 1 was leased by the U. S. Government to be enlarged and prepared for military purposes. The new work consisted of widening the old runways and shoulders; of lengthening three of the four 3,000-ft. runways to 7,000 ft.; of building a new runway; of adding numerous taxiways and hardstanding areas, and of grading intermediate areas to provide visibility, drainage and borrow material. This construction greatly increased the impervious areas and, by removing the grass cover, exposed large areas of raw soil.

Erosion hazards

The surface soils of the field are muck and medium to fine sands (Casagrande classification SP) of uniform grain size. This sand is very unstable and subject to erosion unless confined. The muck, normally unstable, was removed from the graded areas and replaced with other material.

Embankments for runways and taxiways have graded widths of 500 ft. and 200 ft., respectively. The runways and taxiways, including pavement and shoulders stabilized with limerock screenings and then treated with a dust palliative, vary in width from 175 ft. to 400 ft.

Excessive precipitation during May 1943, with 1.22 and 1.23 in. of rain falling during two consecutive hours, caused the initial erosion of the shoulders. Continued heavy summer showers, including an hour rainfall of 2.03 in. on June 6, 1943, resulted in the erosion increasing to the point of endangering the runway and taxiway pavements in spite of continual backfilling of washes and gullies, and regrading after each rain. Gullies 8 ft. deep and 30 ft. wide were eroded in the shoulders and end zones. The erosion usually started at the edge of the shoulders and progressed to the pavement edge.

Drainage plan

In the original airfield the run-off flowed over runways to reach low areas. The drainage system of the field, after expansion, consisted of numerous inlets with storm sewers in the immediate areas except where the topography made extensive drainage uneconomical. The areas without inlets were allowed to drain across the runways or taxiways in accord with the previous design due to the great cost of reconstructing the old pavement. However, the erosion resulting from the increase of imper-

vious areas indicated the necessity for additional drainage. It was determined that by regarding some of the shoulders and intermediate areas, and by providing concrete gutters along the shoulder edges, with spillway chutes and inlets, that the erosion could be controlled.

Design of the concrete gutters and spillway chutes was based upon a storm having a probable frequency of occurrence of once in 10 years; rainfall intensity of 2.9 in. for 1 hr. duration and immediate removal, as no ponding was available. The surface run-off factors used were 100 percent for paving and stabilized shoulders, and 30 percent for grassed areas. *Chapter XXI, Design of Drainage Facilities for Airfields, Engineering Manual* of the War Department, Office of the Chief of Engineers, Washington, D. C., was used in determining the volume of run-off and the required drainage facilities. Where possible, maximum overland flow distances were limited to 300 ft. to hold to a minimum the volume of water flowing across the shoulders, thereby reducing the opportunity for erosion.

The drainage structures

Where possible the shoulders were regarded to shed the water to the outer edges in as short a distance as grading criteria and local conditions would permit. This served to decrease the length of overland flow and restrict water from flowing across runways and taxiways. In shoulder areas where the slope was greater longitudinally than transversely, shallow valleys were constructed, Fig. 2, beginning at the pavement and extending at a 45-deg. angle with the pavement. The valleys were of zero depth and width at the pavement edge, increasing to 3 in. deep and 30 ft. wide at the shoulder edge. These were considered to be non-hazardous to aircraft in case of overrun.

A total of 22,000 lin. ft. of concrete gutter was constructed along the outer edges of runway and taxiway shoulders. Aircraft can run over the gutters without danger of upsetting. The foundations consisted of compacted limerock, shaped and rolled in place. The gutters were constructed of 4-in. non-reinforced concrete and varied in width from 12 to 27 ft. The cross sections were V and trapezoidal shapes. The bottom width of the trapezoidal sections varied from 5 to

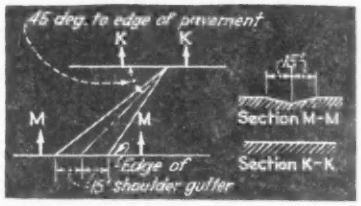

Fig. 2. Shoulder valley used where the longitudinal slope is greater than the transverse slope to divert runoff to shoulder gutter.

15 ft. All gutters had a maximum depth of 6 in. and 1 on 10 side slopes. The respective drainage areas determined the size and shapes of the gutters. A premoulded fiber expansion joint was placed at 25-ft. intervals in the gutters and around all inlets.

Standard concrete inlets were constructed in the gutters perpendicular to the direction of flow, Fig. 3. The water was carried from the inlets through concrete pipe to the discharge point which was protected by headwalls, or stilling basins (Fig. 5) if the velocities and volume were of sufficient magnitude.

Considerable difficulty was encountered during construction of the initial gutters to prevent undermining. Upon several occasions before the inlets and spillways could be completed, heavy thundershowers occurred, in some case washing out the gutters as shown in Fig. 1.

Spillway chutes, Fig. 4, were provided at the bottom of long grades where the volume of water was too great to be controlled safely with inlets. The chutes, with slopes varying from 2 to 10 percent, carried the water from the shoulder gutters to the point of discharge. A well rounded transition section was provided from gutter to chute as shown in Fig. 4. The chute had a rectangular cross section and was constructed of 6-in. concrete with 6x6-in. No. 10 gage wire mesh, with expansion joints every 20 ft. Sod was placed along the sides of the chutes to prevent erosion.

Stilling basins helped

Concrete stilling basins, Fig. 5, were constructed at the foot of all spillway chutes and at the outlets of culverts where the discharge and velocity were excessive. Maximum theoretical discharges and velocities were 27 cfs. and 13 ft. per sec. respectively. The basins are rectangular in cross section and have baffle piers to create a hydraulic jump.

Riprap was provided downstream as a protection against erosion. In addition, the slope of the downstream channel was held to a mini-

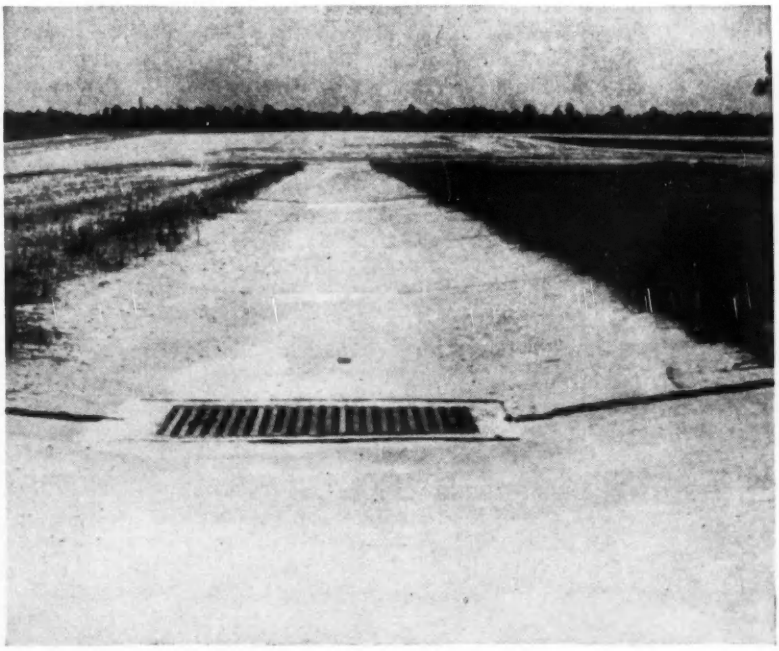

Fig. 3. Shoulder gutter showing inlet to catch basin, which has discharge pipe to headwall or stilling basin outlet.

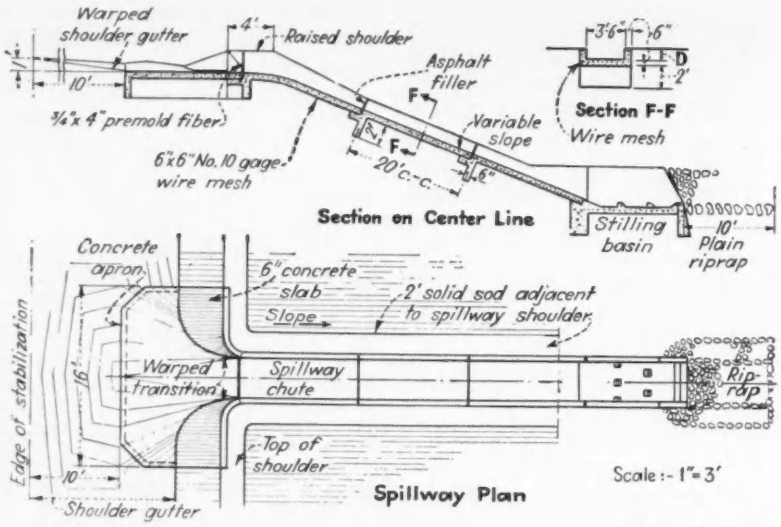

Fig. 4. Spillway chute with stilling basin to dispose of shoulder-gutter flow where the volume is too great for the normal inlet and catch basin construction.

mum to insure a high tailwater and non-eroding velocities.

The additional drainage facilities have had ample trial since installation in November, 1943. During July 1944 a total of 14.20 in. of rainfall occurred. The greatest amount occurring in any 24 hours was 5 in. on July 3 and 4, while the greatest 60-min. amount was 1.62 in. The hourly rainfall producing most of the 5 in. occurred on July 3 as follows: 0.42, 1.36, 0.89, 0.81, 1.03, and 0.21 in.

During passage of the hurricane October 19, 1944, a total of 9.21 in. of rainfall occurred in 24 hr. During the peak of the storm the greatest hourly amounts occurred as follows: 0.36, 0.54, 0.57, 0.71, 1.96, 2.07, 0.90, 0.49, and 0.44 in. Maximum hourly rates for short periods up to and including an hour are as follows: 15 min. 1.25 in., equivalent to 5.00 in. per hour; 30 min. 1.75 in., equivalent to 3.50 in. per hour; and 60 min. 2.77 in. It can be seen that the storm intensity used as the basis of design was greatly exceeded for short periods and practically equalled for the 60-min. period.

Periodic surveys have been made since completion of the drainage facilities to determine their effectiveness in eliminating erosion. The most recent surveys made since the rainfall noted in the two preceding paragraphs show the facilities to be extremely satisfactory in disposing of the run-off without allowing any erosion of consequence. The only erosion noted was a small amount of washing of finer particles from the shoulders due to failure of the grass to grow in limited areas. When a grass cover is obtained the washing of the finer particles will cease.

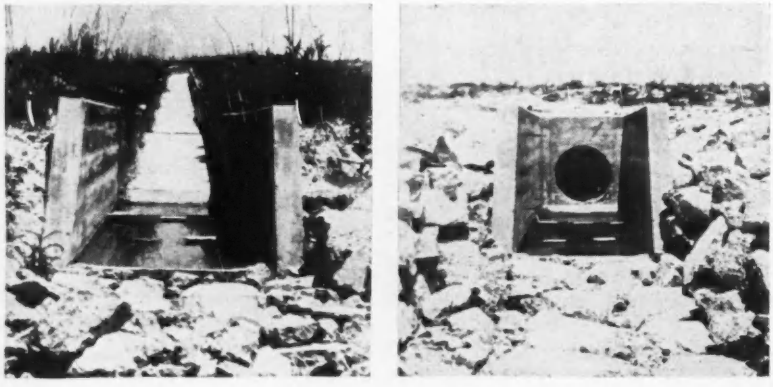

Fig. 5. Stilling basin outlets (left) for spillway chute shown in Fig. 4 and (right) normal gutter inlet shown in Fig. 3.

Construction and design personnel

The work was let by the Corps of Engineers to Contractors Boyd & Goforth, Inc., Jacksonville, Fla. Design and construction were under the supervision of Colonel D. W. Griffiths, district engineer, Major W. W. Vance, chief of operations division, Major S. M. Wall, area engineer, Captain A. H. Miller, resident engineer, E. F. Tippetts, chief of engineering division, Captain C. J. Senerchia, head of airfield-roads, and the writer as head of drainage design.

Edge Insulation Need Shown by Floor Tests

Results of tests of floors laid on the ground and over crawl spaces, as presented in Building Materials and Structures Report, BMS 103, published by the National Bureau of Standards, Department of Commerce, March 10, 1945, indicate that heat loss through a slab floor laid on the ground is more nearly proportional to the length of the exposed edges than to the area of the floor. The edge loss, it was found, for a wood floor laid over a crawl space is small but that of a concrete floor, insulated below but not on the edges, is considerable.

With no ventilation, the crawl space temperature will be between the inside and the outside temperature and will be lower for an insulated floor and for a greater ratio of exposed foundation wall. The heat loss from concrete floors laid over crawl spaces should include both the loss to the crawl space and the loss through the edge.

Information gathered during these tests indicates that a concrete floor may as well be laid on the ground as over a crawl space as far as warmth or heat loss is concerned.

The tests show further that insulation at the edges lowers the heat loss from a floor and reduces the lateral temperature gradient across the floor. Conclusions reached from these observations indicated that edge insulation is more important for floors laid on the ground than insulation under the center of the floor, since the loss through the center is relatively small when the structure is continuously heated.

Notes on Driving Timber Piles

Fred D. Hartford
Bridge Engineer, Public Roads Administration
San Francisco, Calif.

***Contents in Brief**—Use of an auger or churn drill to open a hole, or the assistance of jetting, is suggested to get a timber pile down to required depth in hard material. After reaching approximate depth a few blows of a heavy hammer, preferably on a follower block, produces the required resistance on an uninjured pile.*

ENGINEERS and mathematicians have long striven to reduce the driving of timber piles to a rational formula but it still remains very much an empirical art. Ground into which the piles are driven lacks uniformity in texture and composition. Flood plains of most rivers are underlaid with boulders, gravel, sand or clay in layers or lenses of irregular thickness, inclination and density, perhaps dissimilar every few feet.

Piles themselves vary in size, taper, uniformity of material and elastic qualities. So, piledriving can never be an exact science but some guides from experience may be helpful in securing better foundations.

The uncertainties enumerated, and others frequently encountered, cause the writer sometimes to feel that specification for piledriving should read simply: "Piles shall be driven to practical refusal throughout the structure and to a uniform depth of 10 ft. (or 15 or 20 ft. as local conditions determine) below the lowest point of scour." "Refusal" means that the resistance of the ground to further penetration is in equilibrium with the capacity of the pile to stand further driving. The reason for inclusion of the scour depth rests on a rule of thumb, current for pile trestle bridges in the American southwest, and learned by the author the hard way: "Scour extends two times flood water depth in the channel."

Jet wherever practicable

A treated timber pile that has been jetted into place is a dependable structural member. Such a pile has reached its final place retaining its full value as a column and as a cantilever beam. The pile point has been set tight and unharmed into the bottom stratum with a few sharp blows of the hammer and the core is as springy and solid as the day the timber left the forest. And finally, the ring of preservative, a vital part that has cost the owner as much or more than the timber itself, is intact and can do its full duty in protecting the vulnerable untreated wood of the core.

Unfortunately, jetting is not always practical—the nature of the ground may be such that jetting is ineffectual or a quagmire may be produced giving no lateral support or skin friction to the pile. And sometimes there is insufficient water available for the jetting operation.

Where jetting is not feasible and the desired penetration difficult to obtain, an engineer sometimes consents to the public flogging of an innocent pile that certainly does his profession no credit. Frequently, the top of the pile is given a terrific beating and may even have to be ringed to hold it together. If there are any incipient shakes in the body of the pile, they no doubt are fully opened up by the pounding. Above ground, damage to

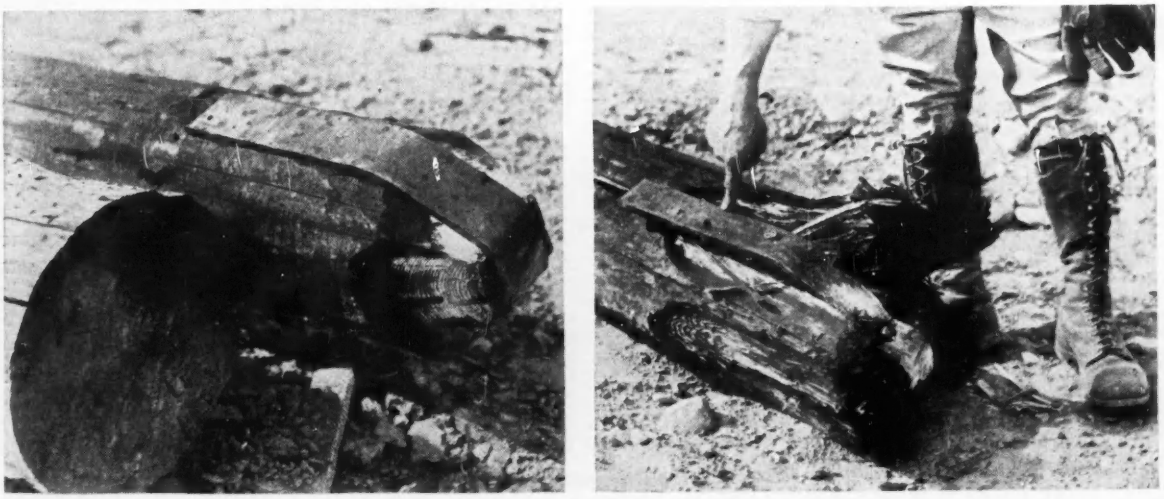

Fig. 1. Treated Douglas fir pile shod with steel strap for driving in streambed filled with boulders and (right) similar pile after driving 8 ft. A pilot hole made with a 10-in. churndrill allowed piles to be driven 25 ft. without damage.

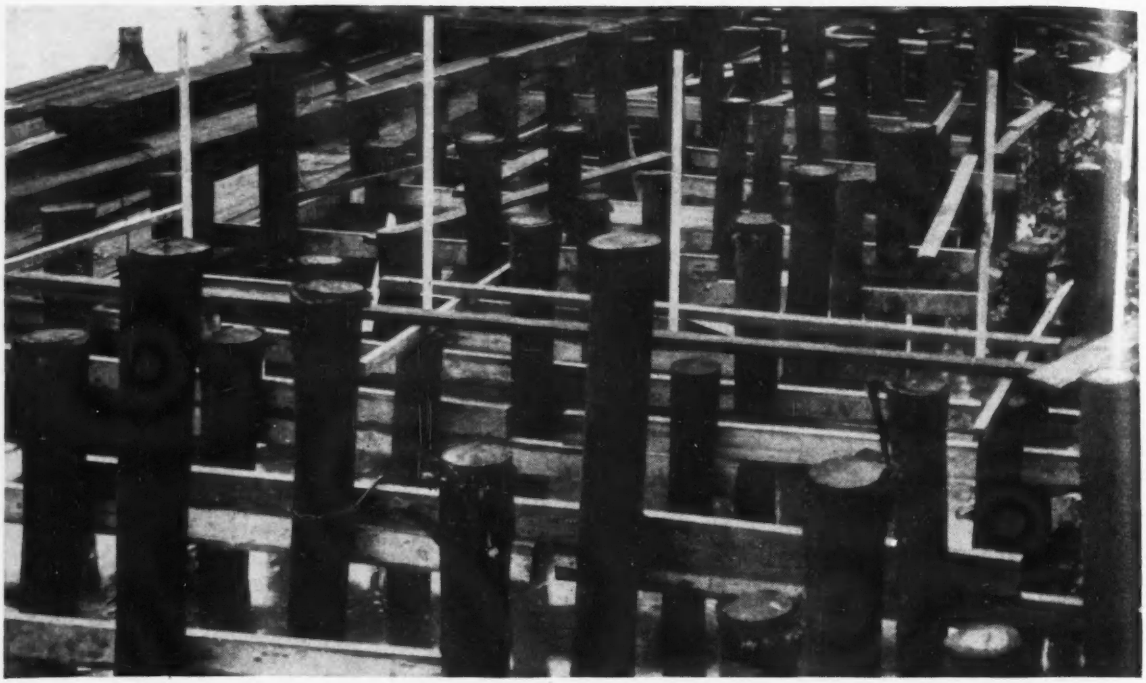

Fig. 2. Piles driven through mixed fill along waterfronts are especially subject to hazards from overdriving.

the treated layer is attested by splinters flying off the surface at every hammer blow. Sometimes checks may be widened so far that untreated wood is exposed.

But below the ground surface, where the structural and preservative elements of the pile are most important—and incidentally unseen—a veritable shambles may exist. Heavy gravel or small, sharp boulders may have so gouged the ring of treated wood that its value is entirely gone. If wedged between boulders, the pile may have been bent so far out of line that it must be pulled almost to the breaking point to bring it back into place. Even though the pile tip has been shod with a steel point, the latter may have been pried off part way down—the tip may be broomed or so split and broken that the value of the pile is seriously reduced.

A timber pile that has been extracted is frequently a sorry sight, scarcely a creditable element in an otherwise sound structure. And for every defective pile pulled out, there are doubtless many like it left in the ground. Again, clever operators have been known to "pull the punches" of the hammer right in front of the inspector busily writing down the average penetration of the last five blows.

As an alternative to damaging a pile in driving through hard material, a hole made with an earth auger or churn drill may be used to ease the strain of driving to the penetration necessary below possible scour or through an overlying bed of hard material above the bearing stratum.

A soil auger, of 14-in. dia. for the usual 12 in. pile, will frequently be found helpful in opening up a hole for insertion of a pile. By boring down to at least stream-bed level, the actual driving can start at the same point as for the channel pile. Depths as great as 30 ft. can be bored in many soils by this method using either a hand-operated or powered truck-mounted unit. If necessary to provide lateral stability or skin friction, any open space around the piles can be filled with dry sand, or even grout.

Fig. 2. Spliced with an untreated length, the creosoted top of this pile failed just above splice when overdriven to get it down into good bearing sand.

Where ground is too hard, loose or wet for a soil auger, a 10-in. churn drill having a total bit and stem length of about 25 ft. will be found a desirable adjunct to the piledriver. Such a drill can readily be swung on the front of the leads and operated with a ½-in. cable from one of the hoist drums while the hammer is raised as high in the leads as possible.

Sometimes it is sufficient just to loosen the ground with the bare drill. More often, however, it is necessary to sink a 10 or 12-in. casing with the drill and withdraw it just before placing the pile. Where the nature of the ground is such that boulders and gravel immediately refill the hole upon removal of the casing, then it may be necessary to use a 15 or 16-in. casing and drive the pile inside before withdrawing the casing over it. A 6 or 8-in. tongue bailer will usually be found desirable to clean debris and mud from inside the casing instead of depending on displacement by the drill to force them out.

When setting a pile in a drilled hole

in rock that is overlaid with mud, the casing usually can be withdrawn and the pile dropped in the same location. However, it is advisable to cut a groove in the lower end of the pile a distance up from the point equal to the depth of the drilled hole so that water and mud can be forced out by the piston action of the pile. In case the overburden is a type of sand that packs it may be necessary to bail the hole and fill the drilled part with clay mud before withdrawing the casing. The mud will prevent sand from entering the hole, but will itself be readily forced out by the pile as it is driven.

Equipped with an auger, a churn drill and a bailer, it is hard to conceive of any soil wherein a piledriver cannot set piles exactly in place and at the same time with no damage to the pile or to the protecting ring of preservative.

Heavy equipment needed

Piledriving sometimes is viewed as a job for anybody and requiring no more equipment than a pair of leads, a hammer and a boiler, all of them the smaller the better to simplify transportation. Foremost in securing a first-class job is the necessity for a really heavy hammer, whether gravity or steam. This can be so readily demonstrated on a small scale that it is surprising more engineers do not realize it. A 2x2-in. survey hub for instance that cannot even be started with a 4-lb. axe can be driven with a 13-lb. maul without damage, through ground as hard as an oil mat.

It has been the writer's experience that a cast steel cap block, weighing about one-fifth as much as the hammer, gives good results. This cap block should have a deep recess slightly beveled and fitting well down over the head of the pile to prevent brooming and a top receptacle giving generous support to the hard wood cushion block.

Regarding small tools on the piledriver: Some specifications forbid the use of cant hooks, peaveys or pike poles since they may break through the ring of treated wood on the pile; compared with the gouging and snagging of the average pile below ground, damage by the aforementioned tools is not important. Moreover, some piles, especially those treated with the creosote-petroleum mixtures, may be as slick as the proverbial greased pig and as difficult to handle safely. To forbid the use of proper tools for handling treated piles greatly increases the danger of piledriving.

Certainly the writer would not care to be working around a piledriver or responsible for the workers' safety where the piles were being lifted into the leads with a manila rope sling as one engineer recommended to him. The imprint made on the surface of a pile by a $\frac{1}{2}$-in. wire rope when lifting is enough to prevent the pile from slipping out of the bight, while the damage done to the pile is of no real consequence.

Top protection important

For protecting the cut tops of piles the writer has seen nothing so simple and workmanlike as a galvanized sheet steel circle with its outer edge crimped into a pie-pan shape so that it fits down over the pile top and requires no cutting or nailing. Nailing at the top of a pile is of questionable value at best and the cutting of the usual sheet metal plate destroys the very water-tightness that the metal is supposed to furnish.

Piling, like other engineering construction, should be adequate, workmanlike and economical. But no matter how excellent the design and plans, the desired ends cannot be attained unless the contractor has proper tools and workmen competent to operate them.

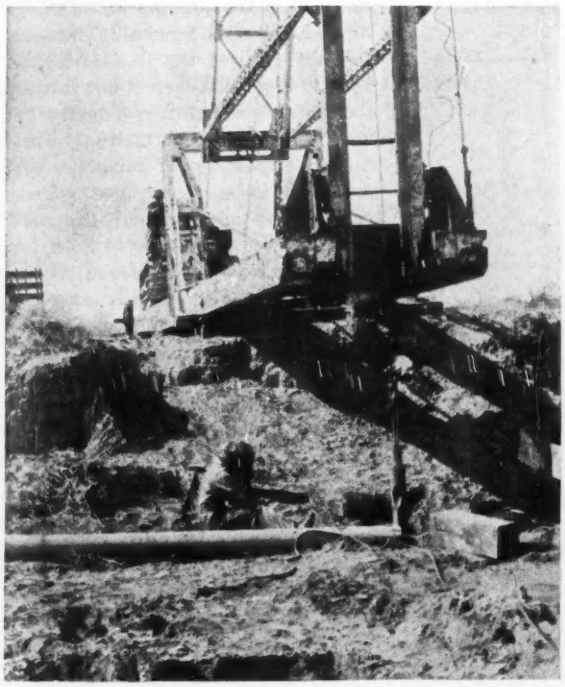

Fig. 4. Drilling exploratory hole with casing at pile bridge site. Drill struck rock at 20 ft. after passing 15 ft. of quicksand. Right, tongue bailer emptying into trough. Note drill stem in foreground and protruding end of drill casing.

Energy Dissipation at Fontana Spillway

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***Contents in Brief**—The Fontana Dam spillway has a fall of 400 ft. with water traveling through tunnels at velocities more than 100 mph. At the end of each tunnel, a concrete bucket of novel design spreads the shooting water into a thin jet that rises to 150 ft. in the air. Where these jets are returned to the natural river the energy dissipation takes place. Substantial scours will have to occur before a stable river bottom is obtained but these scours will in no way affect the safety of the dam.*

ENERGY DISSIPATORS at the foot of the two spillway tunnels at Fontana Dam, built by the Tennessee Valley Authority on the Little Tennessee River in western North Carolina, are of novel design. In principle, they are an adaptation of the bucket-type apron that has been used successfully at many large spillways, notably Conowingo, Apalachia, and at Safe Harbor. This form of apron directs the fast-moving water into the natural river bed downstream from the apron for energy dissipation. It lifts the issuing jet at the end of an upturned apron bucket and leaves a zone of low velocities immediately downstream from the apron, in which no scouring takes place.

Conditions at Fontana are far different, however, from those existing at any of the other sites where this type of energy-dissipating structure has been used. First, is the unusually high head of 400 ft., which produces flow velocities up to 150 ft. per sec. Second, the concentration of discharge is exceeded only by that in the spillway tunnels at Boulder Dam. The two 34-ft. dia. tunnels are designed to carry a flow of 91,000 cfs. each. Finally, the most baffling condition was the eccentric location of the tunnel portals in relation to the natural channel below.

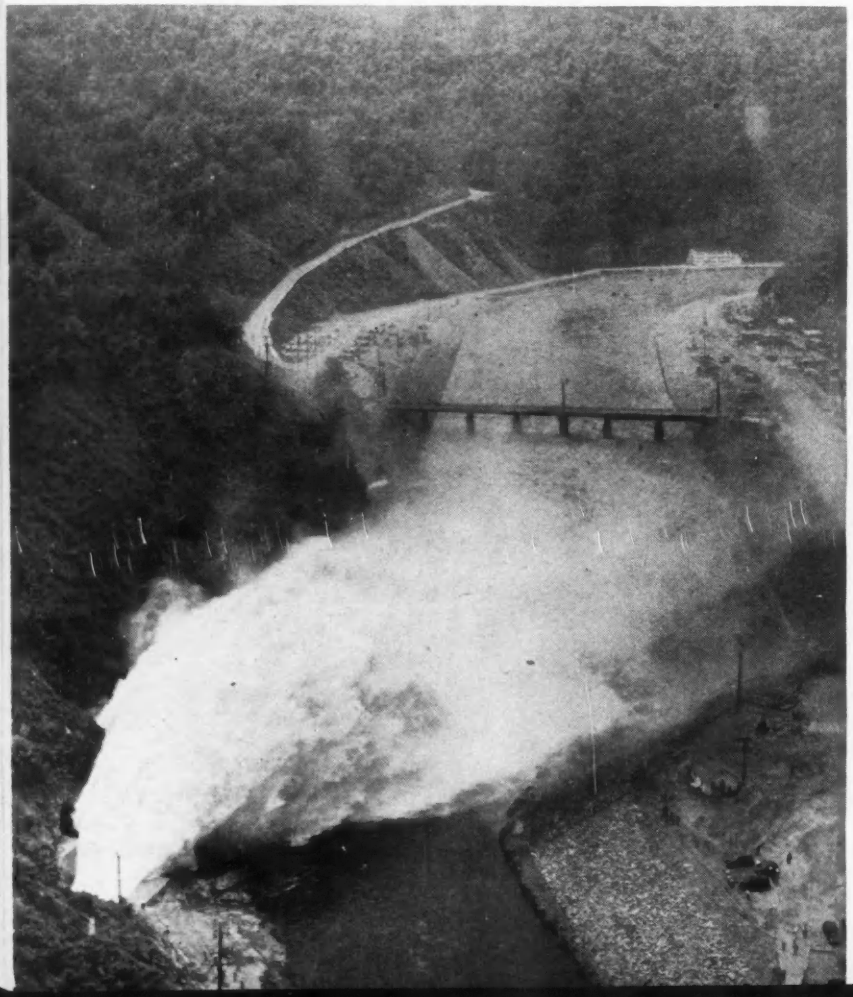

Fig. 1. Spillway test at TVA's 400-ft.-head Fontana Dam. Each tunnel is discharging 10,000 cfs.

Spillway through abutment

Some brief reveiw of the general features of Fontana Dam (*ENR* Nov. 16, 1944, vol. p. 633) is essential to an understanding of the energy dissipation arrangement. The main spillway utilizes the two 37-ft. dia. bore tunnels that were built through the left abutment for diversion of the river during construction. These tunnels are connected by shafts, built on a 1:1 slope, to an ogee spillway on the left abutment of the main dam (See Fig. 2 and 4).

The spillway outlet is regulated by four 35- by 35-ft. tainter gates. At the head of each tunnel, a funnel-like transition widens out to receive the discharge from two of these gates and from three sluice outlets that are set 120 ft. below the crest of the gates. The spillway conduits below the transitions are concrete-lined to 34-ft. dia. At the discharge end of the tunnels the water, traveling at high velocities, has to be returned to the natural river channel. To re-establish tranquil flow, an enormous amount

of energy must be dissipated in this zone.

During the early project studies, when a spillway over the dam was under consideration, it was thought absolutely essential to provide a stilling basin so designed that a hydraulic jump would form for any flow conditions. In other words, a deep scour near the toe of the main dam that would affect the safety of the structure had to be avoided at all costs. But once the layout with a separate spillway through tunnels was adopted, the safety of the main dam ceased to be related to the scouring problem at the spillway outlet. The economical justification of the great expense for a conventional stilling basin had to be questioned.

If an outlet structure could be developed that by itself would be safe under all flow conditions, and which would confine the energy dissipation to a definite area around which stable slopes could be maintained for a flood with a remote frequency, scouring in the river bottom would not be seriously objectionable. This trend of reasoning was strongly supported by consideration of the over-all hydraulic characteristics of the project in multipurpose operation.

Conservative assumption for safety

Due to the great size and storage capacity of the project, and the corresponding magnitude of the catastrophe a major failure would cause, the most conservative assumptions regarding storm intensities, run-off and available reservoir storage had to be made in providing for flood discharges. The main spillway, based on such assumptions, is designed to release 182,000 cfs. But the frequency for even an appreciable fraction of this discharge is extremely rare.

Most of the future large floods will be absorbed in the reservoir, which will be operated to maintain a substantial flood storage during the wet winter and spring season. To retain this margin of storage, discharges through the sluices will be necessary. They will be a rather frequent occurrence during the filling season of a wet year. But these discharges will be in the order of from 2,000 to 10,000 cfs. Discharges of even 25,000 cfs. will be most unusual.

The task of developing an outlet structure could not have been accomplished without the services of a competent hydraulic laboratory. TVA operates its own laboratory, and the work at Fontana offers a good example of the importance of closest cooperation between the design office and the laboratory staff.

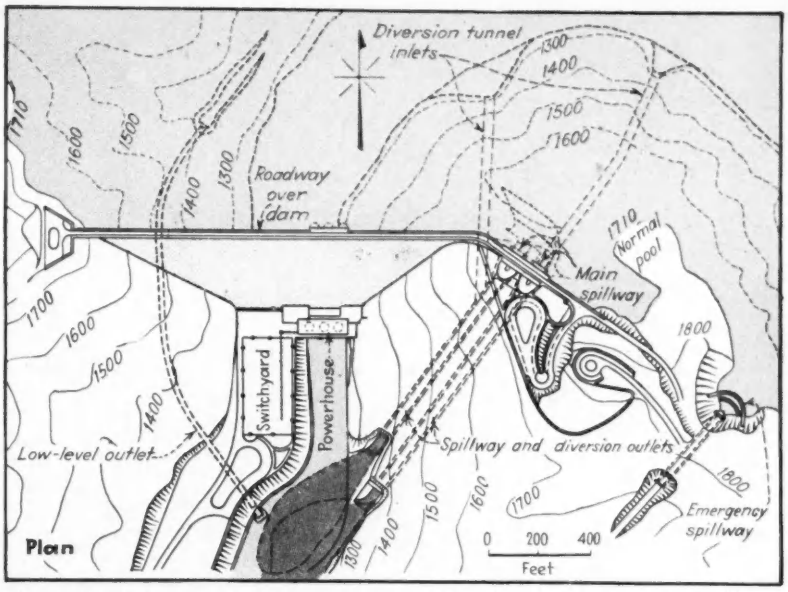

Fig. 2. The spillways at Fontana Dam are through the East abutment. Shown darkly shaded in the foreground is the jet pattern for a flow of 25,000 cfs. through each of the two main spillway tunnels.

First trials in the laboratory showed very undesirable results. Because the tunnels empty into the river eccentrically along one shore line, the discharge introduced a large eddy in the river basin. The returning eddy currents re-entered the main flow channels at great velocities in front of the outlet portals and caused tremendously deep scours around these structures.

Aid from the laboratory staff

To remedy this condition, many alternate arrangements were tried. The tunnel portals were brought side by side by addition of an expensive conduit section to the riverside tunnel. The initial principle was infringed upon in many ways by adding slabs, walls, and dikes in front of this structure, but these compromise arrangements made little progress toward a solution.

It was the laboratory staff who suggested the decisive corrective measure. Instead of carrying the water from the tunnel portal in line with the tunnel axis eccentrically into the river, it was proposed to build the bucket as a separate structure downstream from the portal, so shaped that the jet would be deflected sidewise across the river basin. This arrangement showed promise from the outset.

Many bucket shapes tested

A great number of bucket shapes producing different horizontal and vertical deflections and varying degree of spread of the jet were tried. Around the different patterns of impact zones eddies and waves of varying intensities formed. The outline of the banks around the dissipation basin had an important bearing on the intensity of these eddies. From a number of tests, the bucket shapes and the basin outline giving the best performance for the full range of discharges were finally chosen and adopted for construction.

Accuracy in predicting the action of the buckets depended on the exactness with which velocities of the discharging water in the model and the prototype could be established. Laboratory work was impeded by lack of dependable data both on friction losses and on bend losses for water traveling at high velocities, as they exist in the Fontana tunnels.

A careful study on this subject was carried out by the laboratory staff. For performance tests, discharge velocities at the buckets were assumed to remain within certain bracketed values, for instance, for maximum discharge, to be between 130 and 150

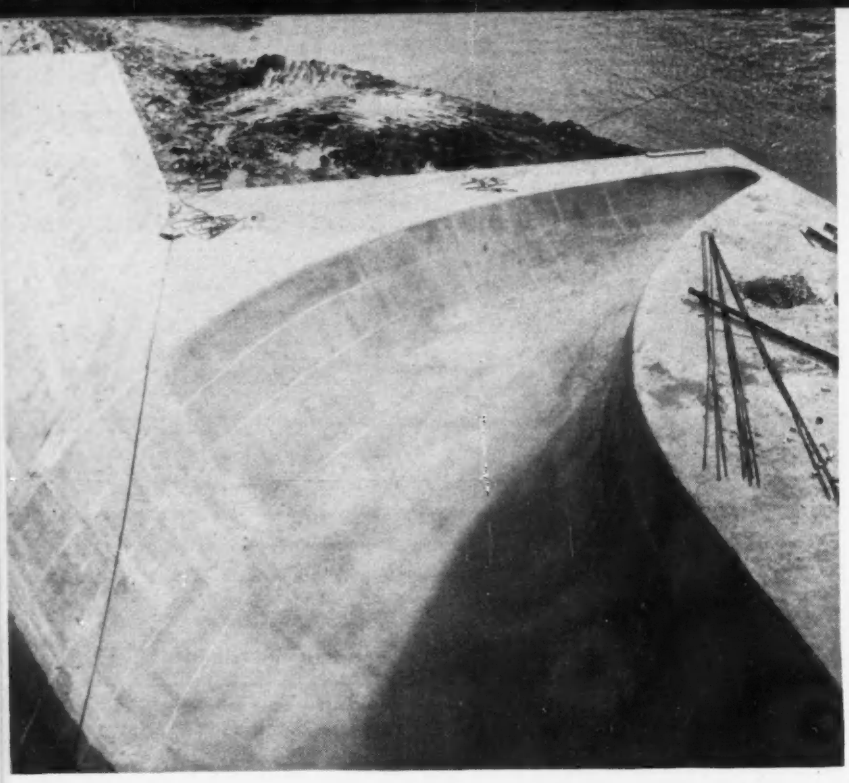

Fig. 3. Bucket at downstream end of one of the tunnels as construction neared completion. Great care was used in getting a dense surface on the concrete.

ft. per sec. Velocities for this discharge were finally estimated to be 142 and 147 ft. per sec. for the long and the short tunnel respectively.

Deep scour expected

Concerning the amount of scour that will ultimately take place in the energy dissipation basin, the laboratory could give only indicative information. Most of the tests were made with a fixed floor in the basin. Tests on a sand floor were unsatisfactory because cohesionless sand does not erode like rock and, late in the test program, a very small amount of cement was added to the sand. In this way a cohesive mass was obtained that still could be scoured by velocities equivalent to 15 ft. per sec. on the prototype. The tests showed scour patterns with depressions as deep as 35 ft. for discharges of 25,000 cfs. per tunnel.

The discharge buckets, as built, are each a concrete block 82 ft. long, about 65 ft. wide and 17 ft. high, into which the shape of the waterway, varying from a half-round section at the portal to a wide horizontal lip at the downstream end, is molded. Concrete volumes of the two blocks are 2,300 and 4,400 cu.yd. respectively.

The buckets deflect the jets emanating from the tunnels both horizontally and vertically and spread the zone of impact over a wide area. The main part of the water strikes the bed along the periphery of the jet. Patterns of these zones for a discharge of 25,000 cfs from each tunnel are shown in Fig. 4. It is expected that at maximum discharge water will be deflected 150 ft. up into the air and it will spread as a fan-shaped jet extending as much as 700 ft. downstream.

The buckets have substantial toe walls into the rock on the downstream side. This protection is necessary because, for water releases of 2,000 cfs. or less, a hydraulic jump will form along the horizontal leg of the tunnel. When this condition exists, the lip of the bucket will act as an overflow weir, and the free fall of about 15 ft. will produce substantial scouring at the foot of the bucket.

Much effort was made to obtain even and smooth transitions in the concrete. All waterway surfaces were vacuum treated immediately after the concrete was placed to remove excess water and produce a dense, wear-resisting surface.

Heavy riprap required

For protection of banks around the energy-dissipation basin, careful measurements of eddy currents and wave heights were made. Tests showed that with increasing discharges, the waves increased considerably. Because washing of a bank would not involve damage to any important element of the project, safe slope protection was limited to the disturbance caused by a total discharge of 85,000 cfs, which corresponds to the maximum flow of record for the uncontrolled river.

Even for this discharge, the weight of stones required on the most exposed banks exceeded sizes ordinarily considered feasible for riprap. How-

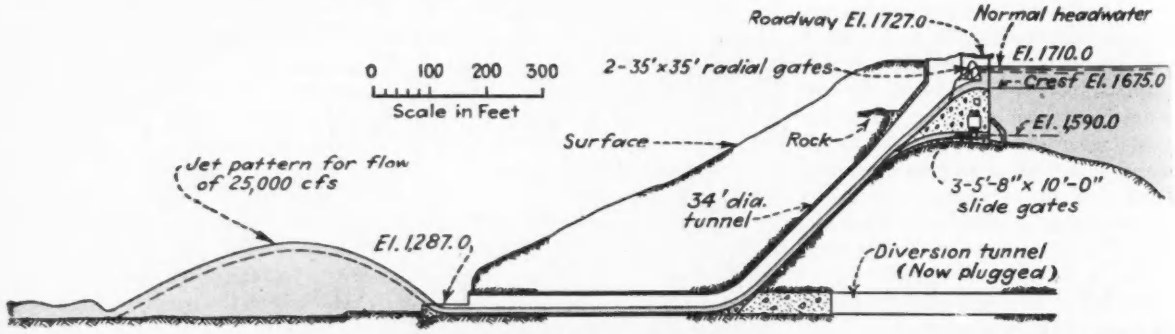

Fig. 4. A cross section through one of the spillway tunnels. Flow of 25,000 cfs. fills only small part of tunnel section. Even when discharging at maximum spillway capacity, tunnel does not flow full.

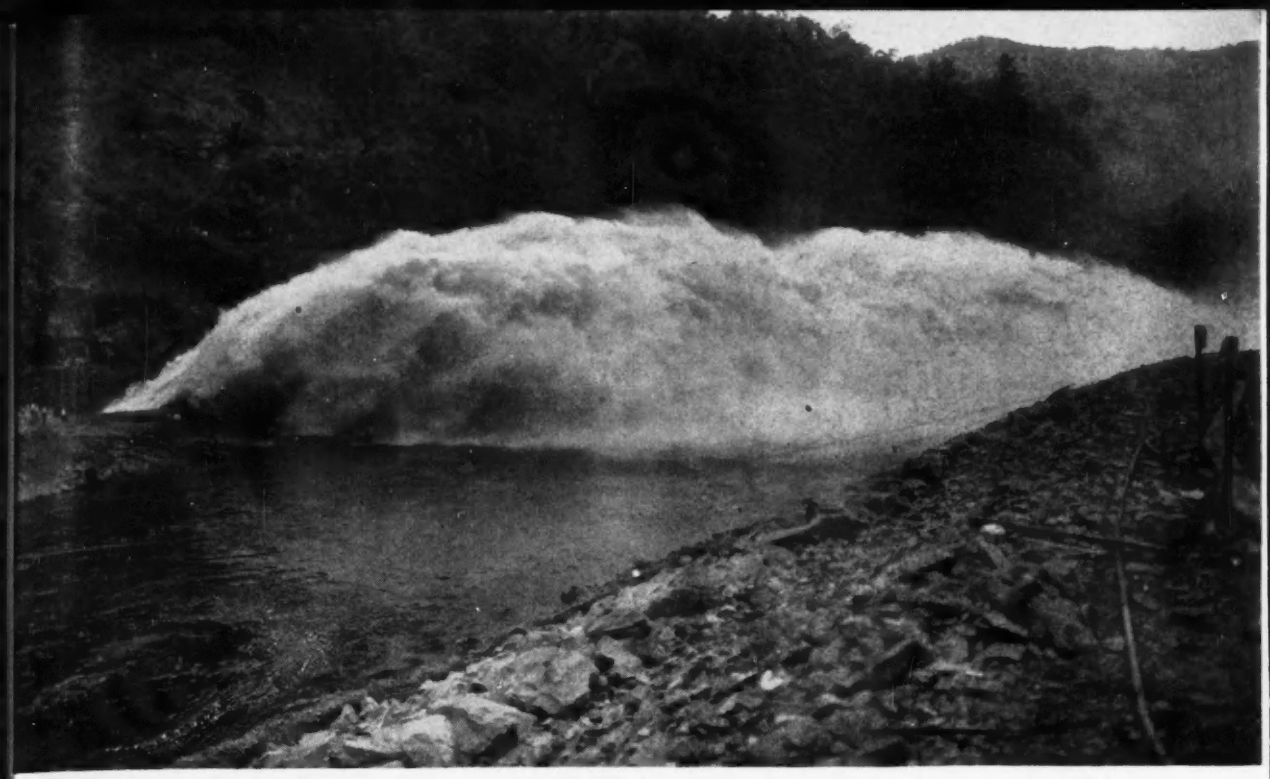

Fig. 5. Jets for a discharge of 10,000 cfs. at each tunnel. Although a great amount of energy is being dissipated in the river basin, the tailrace channel in the foreground is unaffected, its flow being calm and smooth.

ever, during the last few months of quarry operations, *ENR* Aug. 23, 1945, vol. p. 232, large rocks that would have required excessive additional blasting to prepare for the primary crusher, were set aside to be used for this purpose. At the most exposed area, stones weighing six tons or more were specified for part of the riprap blanket. About 2,000 lin. ft. of bank slopes had to be protected along each side of the basin. To protect the base of the slopes, a concrete toe wall was built at the lower edge of all riprapped banks.

The tailrace channel, which was excavated to gain most of the available head between the dam site and the Cheoah pool downstream, passes through the energy-dissipation basin. Laboratory tests indicate that the spillway discharge will have an ejector action on the tailrace channel, causing its surface to be lower than the river surface downstream and thus increasing rather than decreasing the power head at flood flows.

Tested on small discharge

Prototype tests of the spillway were scheduled to be carried out as soon as the reservoir would be filled. By the end of the high run-off last spring season the reservoir had not reached maximum operating level; therefore, the tests had to be made with economy of water. On June 16, both tunnels were allowed to discharge up to about 10,000 cfs. each for a few hours. This performance showed a very close conformity to that expected from model tests.

Two photographs of the jets taken during the test run, Fig. 1 and 5 show clearly how the disturbance is confined to the jet area and its immediate neighborhood. No waves appear in the tailrace channel upstream and the flow in the river channel downstream from the temporary construction bridge is very quiet. The large amount of spray appearing in the pictures was not indicated in the model tests but as it is a characteristic phenomenon of high velocity discharge it was anticipated.

Soundings taken in the dissipating area just before and immediately after the test indicate that scour depressions in the rock floor of the river will be eroded after relatively short durations of flow.

It is expected that the first high run-off year will give an opportunity to establish substantially the ultimate stable scoured bottom for the normal maximum discharge, say about 50,000 cfs. It is estimated that about 60,000 cu. yd. of rock will be broken up in the channel before this stable condition is obtained. Scoured material will have to be removed as it will raise the tailwater level and therefore affect the power output. Removal can be carried out in the dry without a cofferdam during periods the units are not operating.

Because of the low cost of the bucket layout when compared with a stilling basin, the savings in capital charges will far outweigh the occasional expenditures for dredging to maintain good hydraulic efficiency of the tailwater channel. It is estimated that a conventional stilling basin would have cost at least four times the amount expended for the buckets and for the dissipating basin as built.

Engineering staff

All engineering and construction work for TVA is under the direction of C. E. Blee, chief engineer. George R. Rich, until recently, was chief design engineer. The writer is chief of the Civil and Architectural Design Division. G. P. Palo was in direct charge of the preliminary investigation and B. Arneberg is in charge of the final design of the Fontana spillway. George H. Hickox directed the model tests, made at TVA's hydraulic laboratory, located near Norris Dam near Knoxville. F. C. Schlemmer is project manager at Fontana Dam, Oren Reed is construction engineer and G. E. Murphey was construction superintendent.

Competitive Bids on a Cost-Plus-Fixed-Fee Contract

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Consulting Engineers, Chicago

Repair of a 42-in. reinforced concrete trunk sewer posed a problem for the village of Evergreen Park, Ill. because the exact method for doing the job could not be determined without considerable experimentation with various types of materials and work procedures.

Since the village had no force account labor at its disposal, it became necessary to consider engaging a contractor to do the work. The uncertainties and financial risks involved indicated that a lump sum or unit price contract would have resulted in a contract whose price would be unnecessarily high.

On the other hand, the usual cost-plus-a-percentage type of contract was considered undesirable because of the lack of incentive on the part of the contractor to operate in the most aggressive and efficient manner. Furthermore, the task of selecting the proper contractor for such a cost-plus contract would have placed a severe political burden on the municipal official especially if unforeseen difficulties were encountered.

It was decided, therefore, to set up a cost-plus-a-fixed-fee contract, for which sealed bids would be taken on the amount of the fixed fee. In order to distribute the risk as equally as possible between the owner and the contractor, certain portions of the work, the cost of which could be reasonably well foretold, were included in the fixed fee, together with the usual profit and overhead costs. That portion of the work which would be subject to experimentation and other uncertainties was reimbursable under the actual net cost.

It was also desired to keep the contract open to two general methods of repair: (1) renewing the sewer joints from within the sewer; or (2) pressure-grouting the soil surrounding the sewer (with cement or other chemicals) from the ground surface or through the wall of the sewer from its interior.

The following is an excerpt from the contract, illustrating the definitions of the fixed fee and the actual net cost:

"11. *Fixed Fee:* The bidder shall name in his proposal a lump sum for which he will perform and supply the following enumerated services, materials, equipment and supplies. This lump sum bid shall be the basis for comparison of bids. It shall be the only compensation paid to the Contractor in addition to his actual net cost as defined in Paragraph 12 hereof. The fixed fee shall include, but not necessarily be limited to:

(a) Services of a full time superintendent, satisfactory to the Owner, and having authority to act for the Contractor

(b) Services of a timekeeper, clerk-of-work, partners, corporation officers or proprietors as may be required

(c) Interest on moneys, and profit on the entire contract

(d) Contingent fees or commissions

(e) Patent royalties

(f) Rent, heat, light, telephone, office supplies, wages, or any other expenses necessary and usual in the Contractor's home or central office

(g) Travel expenses and subsistence of all employees

(h) The complete cleaning of the sewer as set forth in the specifications attached hereto

(i) Premiums on public liability and property damage insurance as required by the General Conditions, and on fire insurance, motor vehicle insurance, and hazard insurance

(j) The moving in, setting up, operation, operating labor, rental, depreciation, fuel and lubrication, repair, maintenance, dismantling and moving away of all pumping equipment, motor vehicles, lighting equipment, ventilating equipment, hoisting equipment, tools, appliances, specialized clothing, safety devices, and all such other equipment required to meet the specifications or necessary in the opinion of the Contractor to the effective cleaning, dewatering, and repairing of the sewer

(k) The construction, furnishing and maintenance of ditches, flumes, hose lines and pipe lines for the removal of pump discharge, and of temporary bulkheads and dams within the sewer

(l) The costs of hiring, medical examinations, hospitalization, and leave and holiday pay for all employees

(m) The cost of performance bond, bid bond, and the cost of preparing this proposal

(n) The costs in connection with the keeping of records and books of account for the purposes of determining the actual net cost

(o) All field and laboratory costs in connection with soil tests necessary in the opinion of the Contractor prior to pressure grouting or otherwise physically or chemically treating the soil surrounding the sewer

In general, the intent of this Contract is to provide that the fixed fee shall cover all costs incidental to (1) cleaning the sewer, and (2) placing and maintaining the sewer in that condition which, in the judgment of the Contractor, is necessary for the efficient repair of the sewer.

12. *Actual Net Cost:* In addition to the fixed fee lump sum set forth in this proposal, the Contractor shall be reimbursed for his actual net costs in making the sewer repairs as set forth in the specifications. The actual net cost shall include only the following costs and no other:

(a) Wages of all laborers engaged in actually repairing the sewer and/or treating the ground surrounding it, together with the wages of such working foremen as may be required to effectively prosecute the work

(b) Federal excise tax, state unemployment tax, and premiums for workmen's compensation insurance on those wages included in Paragraph 12(a)

(c) All materials incorporated into the sewer structure, those required to change or improve the character of the ground surrounding the sewer, and such other materials as may from time to time be specified by the Engineer."

In addition, wage rates and overtime provisions were set forth, and the amount of cost which would be reimbursable in the event of equipment breakdowns. Rest periods on the surface of ten minutes in every hour were permitted for workers engaged inside the sewer.

Protection for contractor

Two important "safety valves" were included for the purpose of reducing the risk to the contractor and consequently keeping the fixed fee within reason. The first was to protect the contractor against a considerable change in the scope or difficulty of the work, and read as follows:

"The Engineer's estimate for the fixed fee plus the actual net cost of this contract is $5,000.00, and the Owner's appropriation has been predicated on this estimate. If, in the opinion of the Engineer as the work progresses, it is to the Owner's advantage to materially increase expenditures beyond this amount, the Owner will enter into a supplementary agreement with the Contractor providing for an adjustment of the fixed fee."

This clause was used as the basis for a first supplemental agreement during the progress of the work when it was decided to increase the length of sewer to be repaired by about 30 percent.

The second "safety valve" was in the detailed specifications, and provided for a definite total pump capacity to be provided and maintained by the contractor for the purpose of by-passing the sewage flow. This was made the basis of a second supplementary agreement when unseasonable torrential rains occurred toward the close of the work.

The type of contract chosen produced lively competitive bidding, with the two lowest bids on the fixed fee being within 10 percent of each other. The necessity of keeping costs at a minimum under the fixed fee portion had the desired effect on the contractor in that all the work was prosecuted with excellent organization and a minimum of lost time and effort.

While the cost of the work described was relatively small as construction contracts go, it is felt that experience gained may well point the way to the use of competitive fixed fees on large important construction contracts. In selecting contractors under such form of bidding, unusual care and determination should be exercised in appraising the qualifications of the bidders and selection of a contractor should be largely based on his reputation for faithful and efficient execution of construction contracts.

Electric Heating Prevents Freezing On Exposed Water Line

Anatole R. Gruehr
Division Engineer, Electrical Engineering Department
Consolidated Edison Company of New York

During the past winter a 100-ft. exposed length of 6-in. pipe supplying water to a fire protection system was electrically heated to prevent freezing. Under normal conditions there was no flow in the pipe and the pipe could not be drained, since this would defeat the automatic protection feature of the system.

It was expected that new construction in the area would be sufficiently advanced by December to protect the pipe so the exposed length was temporarily covered with a double layer of 1-in. hair felt. Because of delays the construction area remained open throughout the winter and the covering alone appeared inadequate.

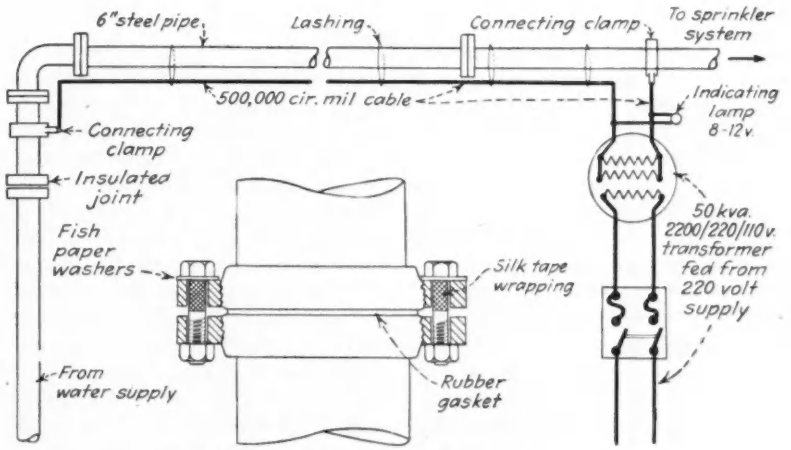
A rough calculation indicated that, with an assumed ambient air temperature of zero degree F. the pipe could be maintained at a temperature above freezing if supplied with heat at the rate of 32 Btu. per hour or 9.4 watts per foot of pipe. A temporary electrical installation was made to heat the pipe with low voltage alternating current. The primary side of a standard 50 kva. 2200-220-110 volt transformer was connected to a 220 volt circuit through a two-pole switch, which was fused for 35 amp. The secondary coils were connected in parallel. Connections were made to the pipe by iron clamps at points about 100 ft. apart, using 500,000-circular mil cable, available on the job.

Current distribution and leakage were determined by measuring voltage drops across 4 ft. of pipe. It was found on first test that parallel path losses to ground through pipe hangers was negligible but that about 28 percent, some 105 amp. of the total secondary current of 370 amp., went to ground at pipe terminals. To reduce this loss, the circuit to ground was opened in the water-meter room by insulating one connecting flange on the ground side of the clamps.

Since the flange bases were separated by a rubber gasket, the current was carried through the iron bolts of the flanged pipe. The first attempt to insulate the bolts, by painting the shanks with insulating lacquer and using mica washers under bolt heads, was unsuccessful. The lacquer and the mica washers were damaged in tightening the bolts. Next, bolts were removed one by one and insulated with a layer of silk tape around the shank and a fish-paper washer under the bolt head. This method was successful and the ground current dropped to a negligible value.

The secondary current supplied to the pipe was about 310 amp. at 9 volts. Power input was about 1,500 watts, or 15 watts per foot of pipe. Temperature of the pipe under the covering was about 40 deg. F. above the ambient air temperature.

The installation of equipment for pipe heating was performed with five man-days of labor with two additional man-days for dismantling. The system required no maintenance and operated without interruption for three months. With the cost of electric energy at the generating station bus about 0.6 cents per kw.-hr., its operation cost was about 22 cents per day or $7 per month. The installation was disconnected as soon as the freezing hazard was over, and the transformer and cable used in its operation were released in good shape.



Insulation of Flanged Joint

Exposed portion of non-circulating water line was protected from freezing by job-built electrical heating system.

An emergency bridge abutment in Ohio was built of precast concrete blocks and transit-mix concrete.

Emergency Concrete Block Abutment

Hobart M. Mumaugh
County Engineer, Allen County
Lima, Ohio

***Contents in Brief**—No timber forms were required in the construction of a small county bridge abutment in Ohio. Precast concrete blocks, forming an integral part of the wall, also served as forms for placing the concrete.*

ALTHOUGH FORM LUMBER ordinarily employed in reinforced concrete construction is no longer so critical as to preclude its use, the following method of constructing a small bridge abutment of precast concrete blocks and transit-mix concrete not only shows what can be done in an emergency, but perhaps points the way to a new field of low-cost retaining wall and bridge abutment construction. .

Following unusually heavy spring rains last year, an old stone abutment supporting a 14-ft. span steel latticed truss bridge collapsed. Immediate construction of a new abutment was imperative to keep traffic moving over the old county bridge.

Two factors influenced our decision to build the new abutment entirely of concrete blocks and transit-mix concrete without requiring any form lumber. One was the lack of sufficient lumber on hand with which to build the conventional type reinforced concrete abutment, coupled with the fact that form lumber could not be secured at that time. The other was our inability to hire form builders. The construction procedure employed proved to be faster and cheaper than the standard method.

No timber forms used

The abutment is 9 ft. high. Basically, it is a cantilever wall constructed by laying up standard 8x8x16-in. precast concrete blocks to form two 8-in. walls set 8 in. apart and supported on the concrete footing. The intervening 8-in. space between the blocks, and the cored holes in the blocks were filled with transit-mix concrete as construction progressed. In this manner the precast concrete blocks not only became an integral part of the 24-in. thick wall, but they also served as forms for the 8-in. thick concrete corewall, thereby obviating the need for any timber forming.

Since the concrete blocks were not very stable against the fluid pressure of the fresh concrete, they were laid up only three courses high at a time. On later jobs, however, it was found possible to build the blocks five courses high without displacement occurring when pouring concrete. After the concrete footing had been placed and properly cured, three courses of concrete blocks were laid up in each of the two walls, using ½-in. flush mortar joints. After this mortar had cured for 12 hrs., the cored holes in the blocks and the intervening 8-in. space was filled with concrete to within 2 in. of the top of the third course. Special care was taken to not disturb the blocks while placing the concrete.

This portion of the wall was permitted to cure overnight and three more courses of blocks were laid up and filled with concrete in a like manner. When the abutment wall and wing walls had been built to the proper height they were topped with a 7-in. thick reinforced concrete cap poured monolithic with the last concrete pour in the three top courses of blocks.

The reinforced concrete cap dis-

tributes the superimposed load of the bridge throughout the entire width and length of the bridge seat, and acts as a T-beam; the cap being the flange and the 8-in. concrete core-wall serving as the stem.

Little reinforcement needed

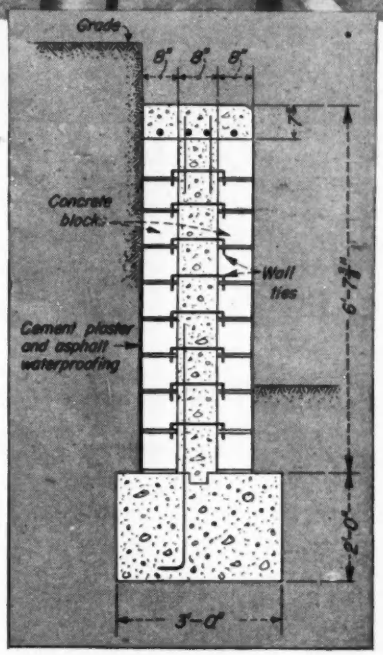
A surprisingly small amount of reinforcing steel was needed. Dowel bars, $\frac{5}{8}$ in. round were embedded in the footing and extended 2 ft. 9 in. up into the concrete wall. They were placed near the rear face of the wall and spaced 18 in. apart. In the wings, bars of the same diameter were spliced to the dowels and extended to the concrete cap. Four longitudinal $\frac{5}{8}$ in. bars reinforced the concrete cap forming the bridge seat. And short pieces of $\frac{1}{2}$-in. rods spaced 18 in. apart anchored the bridge seat to the concrete core-wall.

Wall ties of 1x$\frac{1}{8}$-in. strap iron, with both ends turned down $1\frac{1}{2}$ in., were used in each concrete block of each course. They extended from the center core of block in one wall to the center core of block in the other. Standard corrugated metal wall ties also were used parallel to the face of wall in all joints between the blocks.

The precast concrete blocks as they arrived from the manufacturer had a bearing capacity of 1,750 psi. After the cores were filled with concrete and allowed to cure for seven days they tested 2,600 psi. No 28-day tests were made. The concrete used for filling the cores and in the center wall had a bearing capacity of 4,200 psi.

Upon completion of the abutment the entire rear face of the main wall and wings was given a $\frac{1}{2}$-in. cement plaster coat and a double treatment of water-proofing.

Although this type of construction has its limitations, depending upon the quality of concrete block available and particularly the height of wall to be built, the abutment we built has been in daily use carrying normal county traffic and has proved satisfactory.



Two 8-in. thick block walls (above), serving as side forms for the 8-in. concrete core-wall, also became an integral part of the abutment. (Right) Strap iron wall ties held the blocks together while light reinforcing bars were used as dowels and in the concrete cap.

Detroit Improves Employment System

A strong civil service organization together with a non-partisan civic government are credited for the continued efficient and satisfactory engineer employment in Detroit stated Glenn C. Richards, general superintendent of public works, in a panel discussion of personnel problems at the recent congress of the American Public Works Association in Chicago.

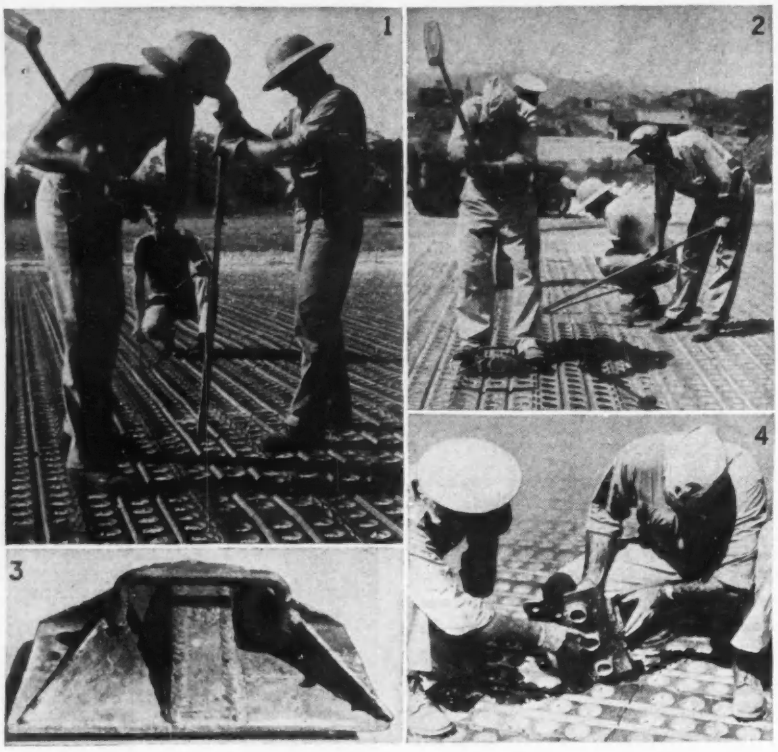
In order to attract dependable employees as well as to retain those already in service the department of public works inaugurated a "self-improvement" program. The plan, which has been in operation for over a year, benefits employees as well as the department, said Mr. Richards.

One major point in the self-improvement program is an in-training school within the public works department designed to aid the advancement of an employee to a more responsible position. Allied with this school is the study and improvement of an employee's habits of speech and dress, and even training in the proper way to answer the telephone.

Salary rates within the department of public works are comparable with those of industry in the Detroit area, said Mr. Richards. Pay rates are published on July 1 of each year, and they are adjusted as necessary throughout the year.

Service records of all employees are kept as an aid to their advancement. Supervisors are required to fill out the service records every six weeks and each employee is shown his rating before it is sent to the personnel office and then to the civil service commission. Any employee dissatisfied with his rating can protest direct to his supervisor and, failing to receive satisfaction, can appeal to the labor commissioner.

No employee is required to join a political group, said Mr. Richards, and neither is he asked to refrain from joining any employees organization. In dealing with its union employees, the department uses the system of collective bargaining without a contract. It also goes on the theory that the foreman is "management" in labor relations. Thus permitting a dissatisfied employee to take his grievance direct to the foreman instead of to the top management.



Old method (No. 1) of removing mat sections required three men and usually damaged the sections removed. With the new device (No. 2) two men remove the sections without damage. Close view (No. 3) of the upper side of the device which the operator "rides" while striking it. Underside of the device (No. 4) has three projecting cylinders that fit holes in the mat.

Simple Device for Removing Sections of Marston Mat

A VERY SIMPLE DEVICE for removing sections of Marston mat from runways, taxiways and hardstands speeds up this operation, avoids damage to the mat and does the work with two instead of three men. The device was developed by the 61st Naval Construction Battalion and was first used in maintenance of Henderson Field on Guadalcanal.

The old method, as illustrated in No. 1 above, was to move the section horizontally 1½ in. by blows of a sledge hammer striking a crowbar inserted in one of the holes in the mat and held vertically. In using this method on sections tightly wedged, the crowbar is likely to damage the section and make it unfit for reuse.

This old method of removal was not satisfactory at Henderson Field because there large sections of mat were damaged by bombings and it was often necessary to take up some undamaged mat in order to get the damaged sections out in a hurry. Good sections damaged by the crowbar in process of removal made just that much more demand on the limited supply of mat which had to be conserved carefully.

Speed was important in this repair work because of urgent need to keep the field continually in service. Planes were frequently coming in low on fuel or damaged in combat. Another point was that mat sections often had to be removed for repairs, making it highly undesirable to cause further damage in the removal process. For example, after a runway is strafed, jagged edges that mark each bullet hole can cut tires in landings and take-offs. In crash landings props often cut the mat, leaving sharp edges requiring sections to be removed for repair.

Simple but effective device

A simple device that met all requirements for effective mat removal was built with material from the scrap pile. Essentially it was a flat plate to which were welded three short cylinders of a size and spacing to fit the holes in Marston mat sections. These projections are fitted into place in the mat and a man with a sledge hammer steps on the device before striking it. Thus his weight helps to hold it in place while the three projections distribute the impact of the blow and thus prevent damage. The man using the sledge hammer and the man who pries up the opposite end of the mat, where it butts against the next section, constitute a complete mat removal crew. The prying up of the forward end is a requirement common to both methods of removal mentioned here.

New or repaired sections are put in with the same device and ordinarily require only moderate taps with the hammer. In cases where the hooks are bent or rusty the device is a decided aid in replacement.

Principal credit for development of the mat removal device is given to Lieut. Jerome B. Paris, (CEC) USNR, the 61st Naval Construction Battalion.

Knot-Free Pine Lumber Grown in Soviet Union

A method of growing knot-free pine boards has been developed in the Soviet Union according to a foreign lumber journal report quoted in "Foreign Commerce Weekly."

The method consists of allowing young pines to make a bushy growth near the ground until they are about eight years old, but pinching off all side buds after that time, allowing no branches to develop above the low growth. The lower branches provide sufficient nourishment for normal growth.

When the tree has attained a height sufficient to produce a log 18 to 20 ft. long, it is permitted to grow a normal top. With no branch bases within the fixed limit, however, the entire log will be free from knots, it is claimed.

From Field and Office

WORKING PROBLEMS AND TIME-SAVING METHODS FOR ENGINEERS AND CONTRACTORS

Trashracks Built of Concrete and Timber

As a war emergency measure in connection with the installation of auxiliary outlet facilities in the right powerhouse at Grand Coulee Dam, temporary trashracks constructed primarily of wood and concrete have been placed in eight of the penstock intake structures. In each structure only the lower portion is provided with racks, part of which are available steel racks from the unused intake for the left powerhouse and the remainder are temporary wooden racks, the total installation consisting of 132 steel racks and 108 wooden units.

A typical temporary rack is shown in the accompanying illustration. It consists of 3x8-in. rough timbers on 10¼-in. centers and separated by concrete spacer blocks. The weight of steel used in each of the temporary racks is approximately 250 lb. To avoid the use of auxiliary weighting, the weight of steel and concrete spacers was made sufficient to counteract the buoyancy of the rack.

Each of the steel racks weighs approximately 4,500 lb. If this design had been used instead of the wooden units, the 108 temporary racks would have required approximately 486,000 lb. of steel as compared to 27,000 lb. actually used.—C. W. BENNETT, *Engineer, Bureau of Reclamation, Denver, Colo.*

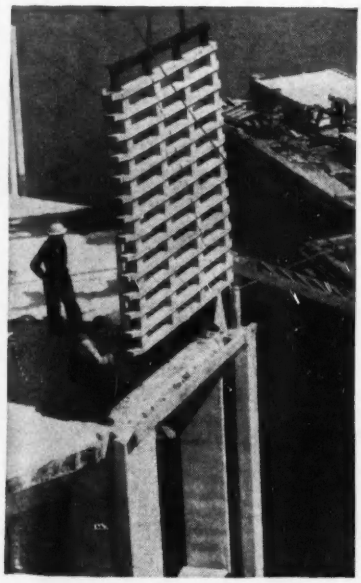
Tilt-Adapter Speeds Mapping From Oblique Aerial Photos

A small metal tilt-adapter provides a highly satisfactory and simple means of utilizing standard wide-angle multiplex mapping equipment (see *ENR* Dec. 12, 1944, vol. p. 750) in the preparation of military maps from oblique aerial photography. Using the tilt-adapter, tactical maps can be produced from photographs taken in one flight instead of the three or four required in the past. Over enemy country, where one swift pass may be safely flown, successive passes over an alerted position become highly dangerous.

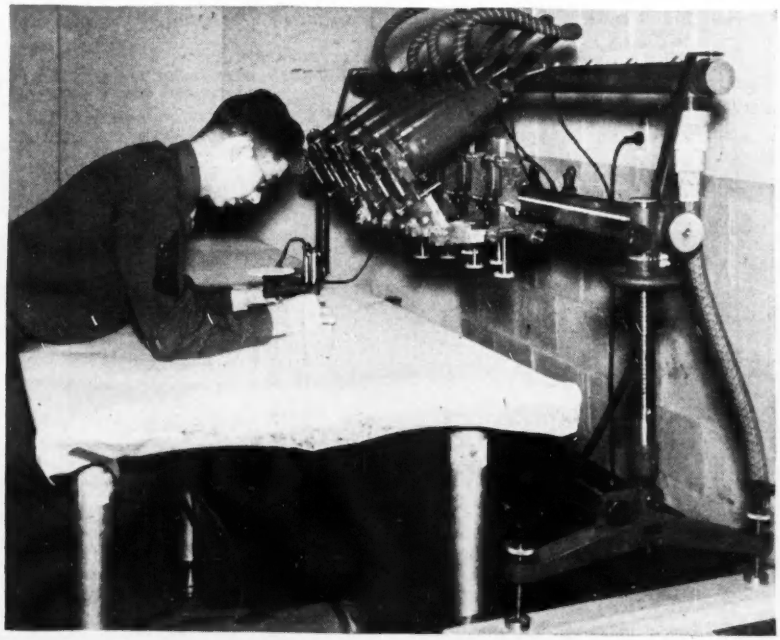
The tilt-adapter, developed by the Engineer Board, Ft. Belvoir, Va., makes possible the compilation of medium- and large-scale topographic maps of suitable military accuracy from aerial photography taken at angles up to 70 deg. from the vertical. Heretofore, mapping from this type photography to fulfill the needs of the ground forces could only be accomplished by bulky and extremely complicated stereoscopic plotting devices not adaptable to military usage.

Special Land Leveller Used at Yakima Project

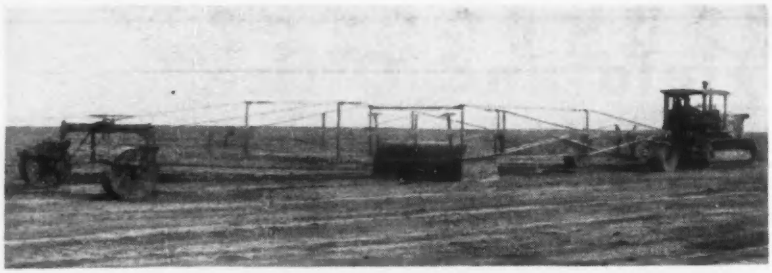
A special land levelling machine is being used to great advantage by two landowners on the Roza Division of the Yakima project of the Bureau of Reclamation. The small-span levellers in common use could not produce the accurate grade required for irrigating a long field in flat country.



To save steel, 108 trashracks for Grand Coulee Dam outlet facilities were constructed of timber and concrete.



Tilt-adapters for multiplex aerial mapping equipment support projectors at proper angle to reproduce exact conditions existing at instant of exposure of oblique aerial photographs taken at angles up to 70 deg. from the vertical.



Permitting a cut 10 ft. wide and as deep as 2 ft., land leveller used on Yakima Project permits accurate grading on long flat fields that are to be irrigated.

The unit, shown in the accompanying illustration, has the extraordinary span of 60 ft. The large hollow metal wheels, of 18-in. tread by 30-in. diameter, are required to prevent the machine from sinking into the previously plowed loose soil. Each wheel is attached independently to the frame like a caster, permitting the machine to turn in its own length. The blade is 10 ft. wide by 3 ft. deep and the cutting edge of the bucket is adjusted by jack screws. A cut up to 2 ft. deep is possible for short distances, depending upon the power of the pulling unit. The machine is essentially a finisher, being used after rough levelling with bulldozers.

Although this is the first appearance of such equipment in this region, the first custom-built land leveller of the type illustrated was used at Knights Landing in the Sacramento Valley in California. The machine shown cost about $2,700, and was custom-built by the Associated Pipe and Engineering Co., Los Angeles, Calif.—H. T. NELSON, *Construction Engineer, Yakima Project, Bureau of Reclamation, Yakima, Wash.*

Capacity of Storage Tanks Increased by Adding to Base

A method by which liquid storage tanks may be enlarged to as much as twice initial size without dismantling the original structure has been developed by the Stacey Bros. Gas Construction Co., Cincinnati. The old tank is literally boosted to its final height as new rings are added at the base by a patented process that makes use of virtually all of the original structure in assembled form. Such re-use, along with the utilization of the original foundation and the minimum dislocation of connections, contributes much to the economy of the process as well as to the speed with which a job may be completed.

As much as 100 percent additional capacity may be added by cutting the existing tank shell at the base, adding new radial plates and building a new shell around the old structure to give the desired height. Water is then run into the tank to the top of the new shell, so that compressed air may be introduced to float the old shell to the new level. Various controls hold the tank steady and level to $\frac{1}{16}$ in., while 4-in. filler plates are inserted between the shells, and the two units are tack welded in place.

When air pressure is released and the water drained from the tank, the two shell sections and fillers are completely seal welded on the outside. Inside, the old shell is trimmed and welded at intervals around its circumference, and the enlarged tank is ready for connections and service.

Originally developed to obtain better buoyancy control of petroleum storage tanks in areas subject to flood, the new method can be used to build up tanks having either umbrella-type roofs or roofs supported by center columns. The inherent economies of this method are expected to be of wide-spread significance in the busy days ahead.

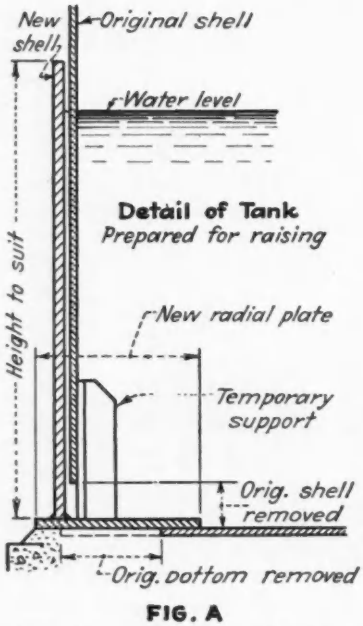


FIG. A

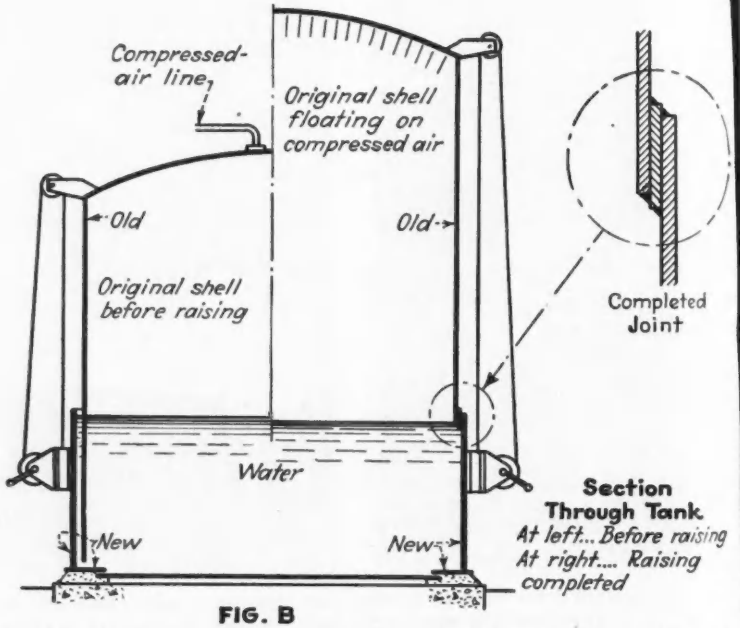


FIG. B

Capacity of liquid storage tank increased by floating original shell on compressed air and adding extension at the base.

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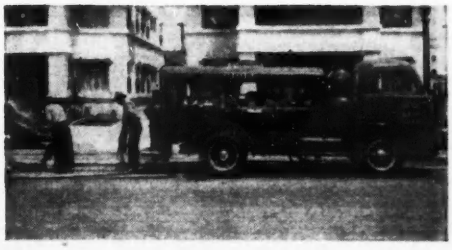

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CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

Substructure for Sewage Treatment Plant, Norfolk, Va.

OWNER: Federal Works Agency, Washington, 25, D. C.; George C. Rothrock, Chief Engineer construction division; Aldrich and Buck, New York City, consulting engineers.

PROJECT: The construction of the substructure for a sewage treatment plant at the Army base at Norfolk, Virginia. The plant was designed for a flow of 11 million gallons per day and will include the construction of a filter building 105 x 77 ft., with a height of 23 ft., a sedimentation basin, 101 x 128 ft. and a depth of 12 ft.; two sludge digestor tanks, 80 ft. in diameter and 30 ft. high. The plant is to be located on filled ground and loose earth and therefore will be supported throughout by piles, necessitating the driving of some 101,000 linear feet of timber pilings. Another important item will be the placing of 5,500 cubic yards of class A concrete masonry.

CONDITIONS: Contractor to furnish all materials and to complete work in 365 consecutive calendar days. Rail and highway transportation facilities available. Wage rates are to be: $1.625 per hr. for skilled labor; $1.10 per hr. for semi-skilled; $.65 per hr. for common.

BIDS: Five bids were received on Oct. 2, 1945, ranging from the contract low of $543,650.00 to $693,955.00. The contract was awarded Oct. 23, 1945.

LIST OF BIDDERS:

1. E. & E. J. Pfotzer, Elkins Park, Penn. (contract) . $543,650.00
2. Reiss & Weinsier Inc., Brooklyn, N. Y. 556,415.00
3. Tidewater Construction Co., Norfolk, Va. 582,550.00
4. Carpenter Construction Co., Norfolk, Va. 631,378.00
5. Calnaught Contr. Corp., Portsmouth, Va. 693,955.00

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Clearing sites and providing field office facilities	Lump Sum	7,000.00	8,000.00	10,920.00
2. Excavation and embankment				
a. Above elevation 0	24,000 cu. yd.	$3.00	$4.50	$3.12
b. Below elevation 0	7,000 cu. yd.	4.00	5.50	7.02
3. Sheeting left in place	20,000 f.b.m.*	50.00	130.00	65.00
4. Furnishing and driving timber pilings				
a. Untreated lengths between 30′ and 40′	7,000 lin. ft.	1.00	.80	.60
b. Untreated lengths between 41′ and 50′	54,000 lin. ft.	1.15	.88	.63
c. Untreated lengths between 51′ and 60′	40,000 lin. ft.	1.25	.90	.61
d. Addt. price per lin. ft. for treating woodpiles	6,000 lin. ft.	.90	.60	.60
5. Class A concrete masonry	5,500 cu. yd.	40.00	36.00	43.87
6. Class B concrete masonry	100 cu. yd.	40.00	20.00	25.68
7. Portland cement added or omitted	100 bbls.	3.00	3.20	2.71
8. Steel reinforcement added or omitted	10,000 lbs.	.06	.08	.045
9. Brick masonry in manholes, fdns., etc.	30 cu. yd.	55.00	50.00	78.75
10. Furnish and install screening equipment	Lump Sum	13,000.00	16,400.00	20,850.00
11. Install equipment furnished by others	Lump Sum	11,000.00	11,000.00	15,010.00
12. Furn. and install inside piping and equipment	Lump Sum	16,000.00	16,000.00	27,270.00
13. Furn. and install misc. metal work	Lump Sum	8,400.00	20,000.00	16,607.00
14. Furn. and install outside gate valves and hydrants	Lump Sum	900.00	2,148.00	2,625.00
15. Furn. and laying outside cast iron piping				
a. 4 in. diameter	800 lin. ft.	2.00	1.36	1.48
b. 6 in. and 8 in. diameter	1,200 lin. ft.	3.00	2.26	2.35
c. 30 in. diameter	110 lin. ft.	18.00	18.88	20.37
16. Furn. and laying outside wrought iron and steel piping				
a. 2 in. diameter and smaller	200 lin. ft.	1.00	1.50	1.00
b. 6 in. and 8 in. dia. steel with dresser couplings	800 lin. ft.	4.00	2.55	4.67
17. Furn. & laying reinf. cover and vitrified tile sewers				
a. 4 in. diam. v. t.	150 lin. ft.	.80	.70	1.26
b. 6 in. & 8 in. diam. v. t.	700 lin. ft.	1.00	1.26	1.60
c. 10 in. and 12 in. diam. v. t.	300 lin. ft.	1.50	1.55	3.18
d. 21 in. and 24 in. diam. reinf. concrete culvert pipe	900 lin. ft.	4.00	4.24	7.88
e. 48 in. diam. reinf. concrete sewerpipe	150 lin. ft.	12.00	14.65	18.64
f. 54 in. diam. reinf. concrete sewerpipe	200 lin. ft.	16.00	15.00	22.42
18. Timber foundation	5,000 f.b.m.	.10	.15	.158
19. Gravel foundation	200 cu. yd.	5.00	9.00	6.00
20. Bituminous roadways and paths				
a. Roadways	5,000 sq. yd.	2.00	2.50	3.47
b. Paths	200 sq. yd.	2.00	1.80	2.63
21. Misc. work in sludge control chamber and elsewhere	Lump Sum	2,950.00	4,335.00	3,710.00

EARTHWORK AND STRUCTURES DESCHUTES PROJECT, OREGON

OWNER: Bureau of Reclamation, Bend, Ore.; F. M. Spencer, acting construction engineer.

PROJECT: Construction of Lateral M-43 and sublaterals, including all earthwork and structures, Deschutes project, Oregon. Work is located approximately 32 to 38 miles north of Bend, Ore. Structures will include checks, chutes, drops, siphons, weirs, turnouts, bridges, culverts and division boxes and are located at various points along the laterals. Earthwork includes rock and common excavation for laterals and structures, overhaul, compacting embankments, backfill, and compacting of backfill.

CONDITIONS: Government will furnish cement, sand and coarse aggregate for concrete; gravel; concrete pipe; metal pipe for weep pipes; pipes and fittings for handrail, and for air vents and drains; lumber for permanent installation; metalwork and gates, etc. for laterals. Contractor to furnish balance of material and complete work in 200 calendar days. Hiring must be done through local USES office to insure that no workers will be taken from lumbering, agriculture or other construction or production jobs which have higher priority rating. Employment of prisoners of war or enemy aliens may be utilized if approved by proper federal agencies having control. Wage rates specified are: skilled labor, $1.375 to $1.85 per hour; semi-skilled, 95c. to $1.25; and common, 95c.

BIDS: Two bids were received August 2, 1945, the low of $245,291, and $299,855.

LIST OF BIDDERS:

1. W. C. Thompson, San Francisco, Calif. (low bidder) $245,291
2. E. B. Bishop, Orland, Calif. 299,855

Item	Quan.	Unit Prices (1)	(2)
1. Excavation, common, for laterals	145,000 c. y.	$0.38	$0.50
2. Excavation, rock, for laterals	1,000 c. y.	2.75	.50
3. Overhaul	7,000 sta. c. y.	.05	.05
4. Compacting embankments	1,400 c. y.	.40	.50
5. Excavation, common, for structures	16,000 c. y.	.90	1.00
6. Excavation, rock, for structures	250 c. y.	4.00	1.00
7. Backfill	11,500 c. y.	.40	.50
8. Compacting backfill	6,000 c. y.	1.00	1.00
9. Concrete in structures	3,550 c. y.	37.50	46.00
10. Placing reinforcement bars	264,000 lb.	.04	.055
11. Dry-rock paving	400 s. y.	5.00	6.00
12. Erecting timber in structures	73 M bm.	65.00	75.00
13. Lay 18-in. concrete pipe	2,460 l. f.	1.30	2.00
14. Lay 24-in. concrete pipe	730 l. f.	1.75	2.00
15. Lay 30-in. concrete pipe	240 l. f.	2.25	2.50
16. Lay 36-in. concrete pipe	45 l. f.	3.00	4.00
17. Install gates and misc. metalwork	33,000 lb.	.15	.15

...a peek into the future—

two brand new asphalt plants

for the bigger jobs —

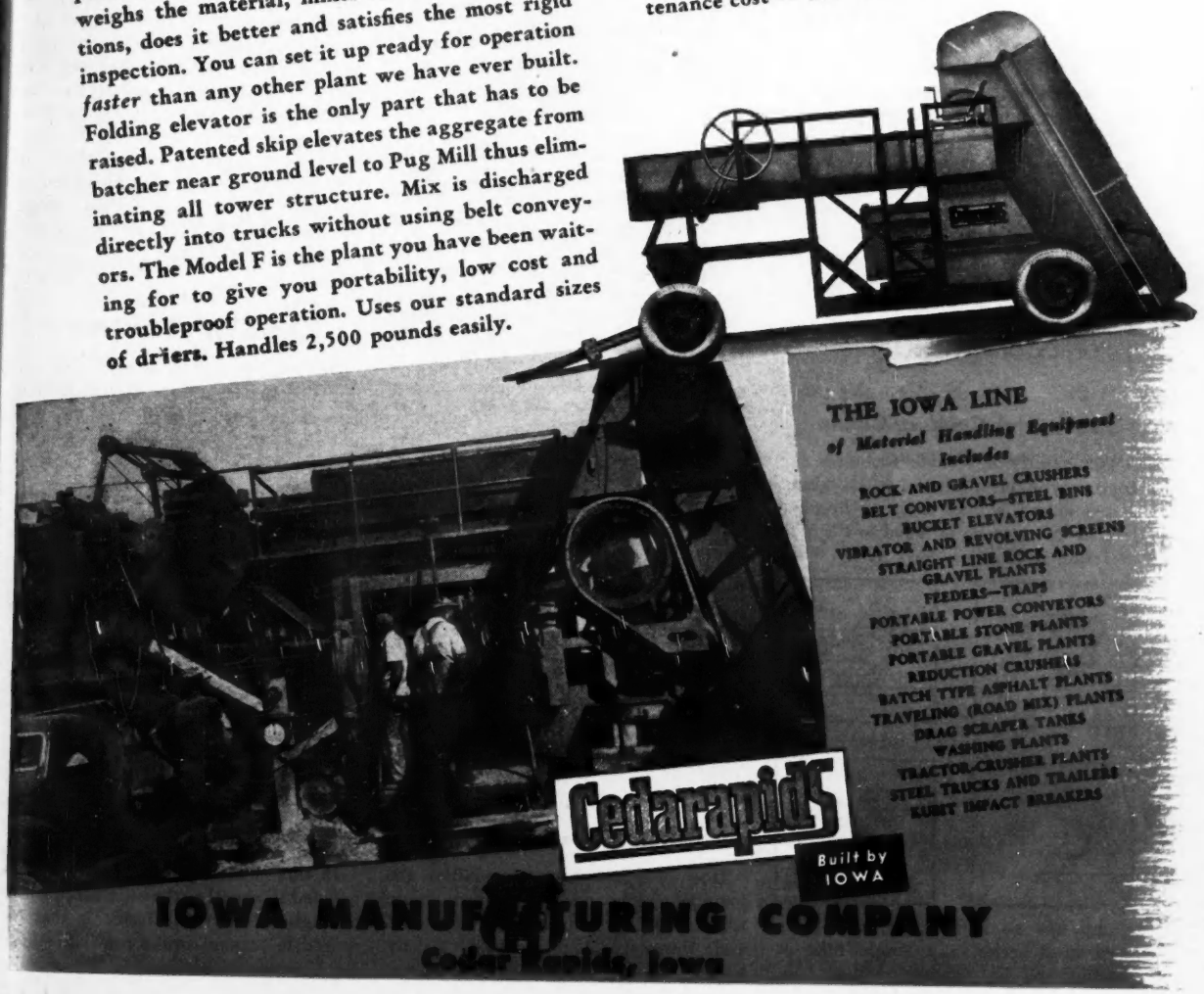
THE MODEL "F"
(batch type)

Here's the most portable, 2,000 lb. batch type plant you ever saw. It grades the aggregate, weighs the material, mixes it to suit specifications, does it better and satisfies the most rigid inspection. You can set it up ready for operation *faster* than any other plant we have ever built. Folding elevator is the only part that has to be raised. Patented skip elevates the aggregate from batcher near ground level to Pug Mill thus eliminating all tower structure. Mix is discharged directly into trucks without using belt conveyors. The Model F is the plant you have been waiting for to give you portability, low cost and troubleproof operation. Uses our standard sizes of driers. Handles 2,500 pounds easily.

for the smaller jobs —

THE PATCHMASTER
(continuous-mix type)

Its name describes it perfectly — the ideal machine for making patch material for anybody's paved roads or streets — anywhere. The Patchmaster is a continuous-mix type plant that will turn out a remarkably accurate mix at the rate of 25 to 30 tons per hour. Available with or without running gear, or drier, this new plant can be used as a portable or stationary plant to meet practically any plant mix problem. Gasoline or diesel engine or electric motor for power. Low priced — Low maintenance cost — Better mixes.



THE IOWA LINE
of Material Handling Equipment Includes

ROCK AND GRAVEL CRUSHERS
BELT CONVEYORS—STEEL BINS
BUCKET ELEVATORS
VIBRATOR AND REVOLVING SCREENS
STRAIGHT LINE ROCK AND GRAVEL PLANTS
FEEDERS—TRAPS
PORTABLE POWER CONVEYORS
PORTABLE STONE PLANTS
PORTABLE GRAVEL PLANTS
REDUCTION CRUSHERS
BATCH TYPE ASPHALT PLANTS
TRAVELING (ROAD MIX) PLANTS
DRAG SCRAPER TANKS
WASHING PLANTS
TRACTOR-CRUSHER PLANTS
STEEL TRUCKS AND TRAILERS
KUBIT IMPACT BREAKERS

Cedarapids
Built by IOWA

IOWA MANUFACTURING COMPANY
Cedar Rapids, Iowa

New Aids to the Constructor

MANUFACTURERS' LATEST DEVELOPMENTS IN EQUIPMENT AND MATERIALS

Air-Entraining Agent

With Darex air entraining agent, the amount of air entrained in concrete can be controlled, and even after an initial mixing period concrete thus treated remains relatively uniform. Such concrete is claimed to have both controlled density and controlled strength.

Darex AEA is a water-soluble compound that comes ready to use in solution form in convenient containers from 5-gal. drums to tank cars. A catalyst —triethanolamine—is incorporated in it to make available more of the inherent strength of the cement, thereby minimizing the loss in strength resulting from entrained air. For average air-entrained concrete, one 55-gal. drum of Darex AEA will treat between 5,000 and 6,000 sacks of cement, and the cost is said to be only a few cents per cubic yard of concrete.

Regardless of the composition of the cement used, the amount of entrained air is controlled by varying the amount of Darex added, and thus certain characteristics of the concrete, such as plasticity, density and durability, will vary with the quantity of the agent. A manual for using Darex AEA, explaining how to estimate the amount to use for a given job and containing other helpful data, may be obtained from the manufacturer.—*Dewey and Almy Chemical Co., Cambridge 40, Mass.*

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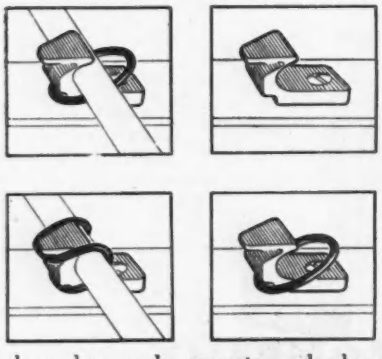
Tube and Conduit Clamp

Particularly adaptable for tube and conduit-type installations of all kinds, a new clamp, shaped after an inverted lateral "S", may be fastened to the wall or frame with an ordinary screw. The



clamp has no loose parts, and when used in a series, any single tube or conduit can be removed without disturbing others. The clamp is also said to be readily adaptable for bonding.—*The Glenn L. Martin Co., Baltimore 3, Md.*

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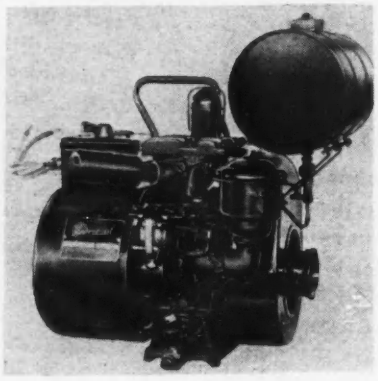
Battery Charger

Incorporating modern design features, two new battery charging light plants



are compact and weigh only 72 lb. Model 256-GH, 6 volt D-C, 250 watts, and Model 312-GH, 12 volt D-C, 300 watts, are completely equipped and present no installation problem; they are driven by a single cylinder, 4-cycle, air-cooled gasoline engine.

A float-feed carburetor and enclosed high tension magneto are said to insure constant, efficient operation. A governor automatically maintains proper engine speed.—*Universal Motor Co., 421 Universal Drive, Oshkosh, Wis.*

• • •

Airport Highway Form

Developed to meet concrete forming requirements in airport slabs from 12 to 24 in. thick, a new form with 10 and 12-in. bases is available in 10 and 15 ft. sections. Dual stake pockets and double treads permit the form to be used with either dimension for the web. Both concrete airport slabs and access roads can be made with a single set of forms.—*Heltzel Steel Form & Iron Co., Warren, Ohio.*

• • •

Instrument Base

Dustproof ball bearing spindles are featured in a new instrument base, which may be installed on old levels and transits. The spindles, tightly locked together and with lubrication sealed in, are said to be accurate and dirt-free.

The base revolves freely at all temperatures. All vertical and horizontal motion can be removed by tightening the bottom nut. Clamps and leveling screws may be cleaned without unsealing the spindles, and the limb and vernier can be cleaned by removing the vernier glass. The base can be installed on any engineer's transit or level, regardless of age or make, the manufacturer claims.—*Brunson Instrument Co., 1320 Walnut, Kansas City, Mo.*

• • •

Road Magnet

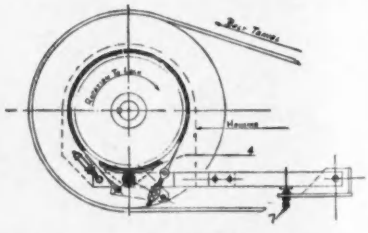
Tramp iron may be effectively swept from the road with a new rectangular suspension, high intensity electro-magnet, it is claimed. This double-gap model has gaps constant at all points to distribute magnetic flux evenly over the entire face and remove tramp iron from all the road area covered.

A generator set carried on the truck bed operates the magnet, which is available in all required sizes.—*Dings Magnetic Separator Co., 509 East Smith St., Milwaukee 7, Wis.*

• • •

Band-Type Back Stop

Devised to prevent loaded belt conveyors or bucket elevators from running backwards when power is shut off, a new 12, 18 or 24-in. dia. drum size back stop features a shoe acting directly on the brake drum. This shoe takes an appreciable part of the load away from the brake band; when the differential acts and the band tightens, the shoe is



pulled up against the drum with great force.

In this back stop, braking forces are resisted internally; the only force going through the conveyor frame is that required to prevent brake rotation.—*Barber-Greene Co., Aurora, Ill.*

HOME for them!

and the HOME STRETCH for YOU!

You still have time! In December, your employees' allotments to the Victory Loan through your company's Payroll Savings Plan offer a final chance to help speed the proud homecoming of our fighting men—and do all in medical power for our hospitalized heroes!

Make December a plantwide TOP-THE-QUOTA drive! Now's the time to spotlight your Payroll Savings Plan—and "brief" your Bond-selling organization for fast, last minute action!

Resolicit every employee to buy the New F.D.R. Memorial $200 Bond

The new Franklin Delano Roosevelt $200 Bond—better than actual cash because it earns interest—is a strong building stone toward the secure future of every employee-purchaser!

From now 'til the New Year—with plant rallies, interdepartmental contests and resolicitation—keep Payroll Savings Plan Bond-buying at a new Victory Loan high! Buying a Victory Bond is the best way of saying "Welcome Home" to our returning veterans! Also an active aid in assuring prosperity to your nation, your employees—and your own industry!

VICTORY LOAN

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ENGINEERING NEWS-RECORD

This is an official U.S. Treasury advertisement prepared under the auspices of the Treasury Department and War Advertising Council

FOR MODERN LUBRICATING OF HEAVY EQUIPMENT

A shot of lubricant at the right time will keep your machinery at work without complaining. The right time, of course, is in accordance with your "lubrication schedule" and there's only one way to make certain that your schedules are kept. Keep a Graco Convoy Luber "on the job".

The Graco Convoy Luber is a self-contained, air-operated, high pressure, portable unit that brings the right lubricant to your equipment. Its heavy duty pumps dispense track, gear, chassis or hypoid lube. Essential hand guns, tools and accessories are standard equipment. Tires can be serviced by the 50 foot air line.

The New GRACO BLOCKBUSTER

● This is a handy sure-fire high pressure lubricating pump, easy to fill and to use. Its double action gives up to 4,000 lbs. pressure and you can depend on it to give you long time service. Write today for latest catalog No. 201.

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GRACO

Elections and Activities

New officers of the Building Officials Conference of Virginia are: Donald R. Locke, Arlington, president; A. R. Lash, Arlington, vice-president; L. B. Dutrow, Front Royal, second vice-president; and W. G. Wharton, Richmond, and E. F. Perkins, Roanoke, executive committeemen.

J. A. Potts, general engineer in the executive department of the Wisconsin Electric Power Co., has been elected president of the Engineers Society of Milwaukee, Wis., an organization of some 1,300 members. Ernest Szekely, president of the Bayley Blower Co., Milwaukee, is the new vice president. New directors include V. Robins Tate, vice president and secretary of the Perfex Corp., Milwaukee; Robert Cramer, Jr., assistant chief engineer at Nordberg Mfg. Co., Milwaukee; P. G. Ellis, budget director of the Wisconsin Public Service Corp., and Harry Gute, assistant engineer in the blower and compressor department at Allis-Chalmers.

The Puerto Rican section of the Caribbean Aqueduct Association has been organized under the direction of the following board of directors: Alberto Hernandez, chairman; Jose Rivera Leon, vice-chairman; Luis A. Velez, secretary; Captain Nelson Biaggi, treasurer; and Enrique Vilella, member.

J. C. Anderson of the Central Illinois Light Co. was recently elected president of the Peoria Engineering Council, Peoria, Ill.

William R. Wallace has been re-elected president of the Utah Water Users' Association. New officers include D. D. Harris, Layton, first vice president; George D. Clyde, Logan, second vice president and Alonzo W. Watson, secretary-treasurer.

H. L. Blanton, Franklin County engineer, has been elected president of the Washington State Association of County Engineers, H. O. Walberg, Skagit County, vice-president and A. G. Hanson, Klickitat County, secretary-treasurer. The county commissioners elected J. F. Lester, Chelan County, president, E. C. Carr, Skagit County, vice-president, Fred G. Redmon, Yakima County, treasurer and J. Harold Sparkman, Kings County, secretary.

MEN AND JOBS

(*Continued from page* 59)

C. D. Houtman has opened an office in Media, Pa., for the practice of civil engineering, land surveying, municipal and structural engineering. Mr. Houtman got his C. E. degree at Brown University in 1916. As assistant county engineer for Delaware County, Pa., for the last twenty years he pioneered in the field of stone-faced concrete bridges. Serving on Media Borough Council he initiated and supervised an extensive road, sewer and water works program.

Gerald H. Ehinger, representative of the Portland Cement Association in its Charlotte, N. C. territory, is leaving to open an engineering business of his own at Albermarle, N. C. He was resident engineer with the North Carolina State Highway and Public Works Commission for many years. In 1942 he became associate engineer with the U. S. Engineer's office at the Greenville, S. C., Air Base.

Carl E. Miller, formerly of Lockport, N. Y., but now of Alexandria, Va., has been granted a leave as engineer in the War Department to embark soon for a six-months assignment in China, where he will assist the Chinese government in a survey of power production facilities and available fuels.

Winfield H. Arata, who recently completed a term as civil engineer with the U. S. Army Engineers, has been appointed executive secretary and manager of the Northern California Chapter, Associated General Contractors.

Arthur F. Ranney, Summit County, Ohio, engineer has accepted appointment on a board of engineering consultants created by Thomas H. MacDonald, U. S. Commissioner of Public Roads. The board will set up standards for the secondary road programs of the state and consult with county engineers and other local officials about their road improvement programs.

Angus N. McPhee has been appointed assistant city engineer at Bremerton, Wash.

W. A. White, connected with Ford Bacon & Davis, Inc., for 27 years, is now at Charleston, W. Va., in charge of a new field office to carry out the design of projects for Carbide and Carbon Chemicals Corp. From February, 1942, to May, 1945, he was engaged on war contracts. Two and one-half years of that period were spent in the Charleston office as project engineer in charge of design on the construction of a butadiene plant for Defense Plant Corp. and nine months at Clinton Engineer Works near Knoxville, Tenn. on construction of a project for the U. S. Engineers.

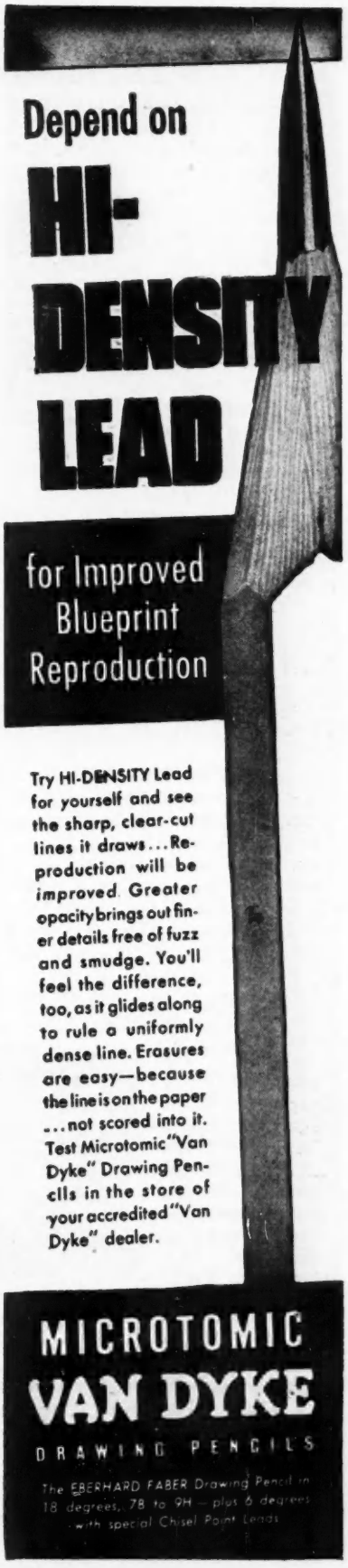
Joseph L. Quinn, Jr., Indiana state sanitary engineer, technical secretary of the Indiana Stream Pollution Control Board, and a member of the Flood Control and Water Resources Commission, has resigned to become assistant to Anton Hulman, Jr., president of Hulman and Co., Terre Haute baking powder manufacturers. A graduate of Purdue University, he was previously with the State Highway Commission and the civil engineer's office in Indianapolis and Bedford and the Lawrence County engineer's office.

Joel C. Beall, sanitary engineer who directed the launching of the typhus control program of the Memphis and Shelby County, Tenn., Health Department, has resigned to take a position with the United States Public Health Service in Atlanta. He will be in charge of typhus control work in one of three large groups of counties in the southeastern area.

Maj. Rolf Eliassen, Corps of Engineers, has been transferred from the repairs and utility section of the 9th Service Command to the American University at Biarritz, France, to be in charge of the sanitary engineering department of this newly established school operated by the Army. Before entering the service, Major Eliassen taught sanitary engineering at New York University.

Guy H. Elbin, for the last eight and a half years bridge engineer for the Franklin County engineering department, has been appointed chief engineer, bureau of bridges, for the Ohio Department of Highways. He succeeds William S. Hindman.

Mr. Elbin is a graduate civil engineer from Ohio Northern University and Iowa State College. At Ohio Northern he was professor of civil engineering for thirteen years, and acting dean of the College of Engineering for two years. He has also been an engineer for the Toledo division of the Pennsylvania Railroad, design engineer for the Carnegie Steel Co., bridge engineer for the state highway department, deputy county engineer of Hardin County and chief specifications engineer for the Works Progress Administration of Ohio.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Manufacturers' Activities

THE BARBER ASPHALT CORP., Barber, N. J., has announced the appointment of Clark Moore as manager of its asphalt paving sales department. Mr. Moore was president of the Equitable Asphalt Maintenance Co. of Kansas City, Mo., manufacturers of road paving machinery. He has recently been connected with the Smaller War Plants Corp. as assistant regional deputy director.

The Barber Asphalt Corp. in addition to its oil refinery and oil asphalt operations at Perth Amboy, N. J., will resume the importation of Trinidad asphalt for paving and industrial purposes. The company also has extensive holdings of gilsonite, a form of industrial asphalt found only in Utah.

PHIL G. GREGG is now with the Machinery & Supplies Co. of Kansas City, Mo., in the sales engineering department. Previously he had been with the Union Wire Rope Corp. of Kansas City, in the sales department and prior to that, with the Sterling Machinery Co. in the engineering and sales departments. During the war he was with the Consolidated Vultee Aircraft Corp. in its tooling department for two and one half years at Vultee Field, Calif.

ACCORDING to an announcement by the LeRoi Co., Milwaukee, Wis., A. J. Bartlett is now responsible for the sale of industrial engines to original equipment manufacturers. Mr. Bartlett, who majored in mechanical engineering at the University of Wisconsin, has been with LeRoi since 1935. Starting as a draftsman, he progressed through the experimental department, where he engineered fuel economy tests on engines and air compressors, and the sales department which he joined in 1938 as a sales engineer. There he organized the product order department and handled engineering and engine application sales.

HENRY J. KAISER has announced the appointment of Peer Neilsen as general manager of the Fontana steel mill in Southern California. Until recently Neilsen held a similar position in the government-owned steel mill at Geneva, Utah, operated by a U. S. Steel Co. subsidiary. He has been responsible for Geneva production since 1943. An engineering graduate of Lehigh University, Neilsen had been with U. S. Steel for 21 years.

NEWLY-ELECTED officers of Michigan Steel Tube Products Co., Detroit, are: George L. Miller, vice president in charge of sales; F. W. Sexauer, sales manager; R. O. Berg, vice-president in charge of research and engineering; J. C. Thrasher, vice-president in charge of operations; Harry J. Longway, comptroller-officer manager, and E. C. Hobart, secretary-treasurer.

ARTHUR H. BROWN has been named manager of sales for Pittsburgh and vicinity, for Lukens Steel Co. and subsidiaries, By-Products Steel Corp., and Lukenweld, Inc., Coatesville, Pa.

Brown, who has been associated with Lukens since 1930, has been a member of the direct sales staff. Previously he was a marine service engineer, a member of the New York sales office, and of the steel plate and flanging sales offices in Coatesville. He has also worked in the mechanical and standards departments.

MARQUETTE CEMENT MFG. CO., Chicago, has created a department of public relations, to be headed by Jack K. White, recently discharged veteran of 32 months of infantry combat service in the Mediterranean Theater of Operations. Prior to his Army service as captain with the 34th Infantry Division, White had been employed in the editorial departments of the New York Times, the New Yorker magazine and Esquire publications; also as a writer for the radio and editor of a real estate trade journal in Chicago.

GASOLINE-POWERED industrial tractors are again rolling off the assembly lines in the Towmotor Corp. plant, Cleveland, Ohio. Production of these units, which Towmotor had been building since 1919, was halted in 1941 to allow the company to concentrate upon the manufacture of lift trucks.

H. F. KNEEN has been named vice-president in charge of manufacturing, and G. G. Landis, vice-president in charge of engineering for The Lincoln Electric Co., Cleveland, Ohio.

H. F. Kneen

Mr. Kneen joined Lincoln in 1929, a few years after his graduation from Cornell University, where he received a master's degree in industrial engineering. Promoted from his original position of assistant plant superintendent to general plant superintendent in 1931, he has been largely responsible for carrying out the incentive plan instituted by President J. F. Lincoln. His success in handling men in the company had considerable influence in bringing about the present harmonious relationship between shop workers and management.

Mr. Landis has been with Lincoln Electric for over 20 years. He was graduated at Ohio State University in 1922. He entered the Lincoln laboratories in 1924, and was promoted to chief engineer in 1930. Many patents on both arc welding and electric motors have resulted from his work.

G. G. Landis

Vice-president Landis is a director of the company and has complete charge of the design and production engineering on welding equipment.

THE APPOINTMENT of Guy J. Coffey as vice-president in charge of sales of the Chicago Pneumatic Tool Co. has been announced. He has been manager of the Los Angeles district office since 1939.

Mr. Coffey was selected because of his successful record in selling and sales management. He joined the company in 1933 as salesman in the Philadelphia branch, being advanced to the Cleveland office, finally to manager of the west coast office. In 1919 he became plant engineer of the Detroit Steel Casting Co., a position he held for 11 years. He resigned to become special sales engineer of the Black & Decker Mfg. Co.

Manufacturers' Publications

Tramrail Systems—A fully illustrated 12-page brochure on tramrail systems analyzes material handling costs and illustrates below the hook devices, a large variety of ceiling fittings, teerails, beamrails, switches, yoke assembly, trolleys, cranes, and shielded electrification for conductor bars. *The Forker Corp., 1847 East 47th Street, Cleveland 3, Ohio.*

Tractors—In this publication the manufacturer outlines the three zones of earthmoving; power area; slow speed hauling area, and high speed hauling area. How two types of tractors meet the requirements of these three main zones, and how they adapt themselves to the varied problems of earthmoving is told by words and photographs in 12 pages. *Caterpillar Tractor Co., Peoria 8, Ill.*

Central Heating and Air Conditioning—This book discusses the economics of supplying heating, cooling and other services to a planned housing project from a central source. The project used for the study is an apartment group. The book gives a detailed analysis of the subject with blueprints, cost tables, etc. An appendix describes case histories where central heating is now operating advantageously. *The Ric-wil Co., Cleveland, Ohio.*

Metal Spraying Equipment—An illustrated circular gives information on a metallizing gun, including construction features, exploded view of gun parts, spraying speeds and gas consumption. The circular also shows the equipment necessary for a complete metallizing set-up. *Metallizing Co. of America, 1330 W. Congress Street, Chicago 7, Ill.*

Valve Lubricant Manual—Featuring the uses of lubricants in lubricated plug valves, a reedited manual has been issued. It gives complete instructions in application of valve lubricants and lists 40 types in stick and bulk form, including a silicone type. More than 100 specific valve services are included, with corresponding lubricant recommendations, for various conditions of line fluid, temperature and pressure. *Merco Nordstrom Valve Co., 400 Lexington Avenue, Pittsburgh 8, Pa.*

Ring Gaskets—A booklet gives complete information and buying data on forged gaskets made of ingot iron, nickel, chromium and monel metals. These gaskets are suitable for high pressure and high temperature service, and various applications and advantages are presented for different service requirements. *Steel Improvement and Forge Co., 970 East 64th Street, Cleveland, Ohio.*

Weekly Wall Calendar—Large numerals of each week are combined with the current, previous and following month in this calendar, which includes a section of technical data covering wire and sheet metal gauges, screw threads, etc. *Frederick Post Co., Box 803, Chicago 90, Ill.*

Lead-lined Steel Pipe and Fittings—It is said that very little of the information on expanded lead-lined steel pipe and fittings, valves and prefabricated lead fittings in these booklets has been printed previously. The catalogs also describe, in some cases, products which have never before been made. *American Smelting and Refining Co, 120 Broadway, New York 5, N. Y.*

Diesel Tractors—The qualities of a diesel tractor are thoroughly described in a 32-page color catalog. Specifications and a complete line of matched equipment are listed. This company has also issued a booklet on the benefits of "Caterpillar" ownership. — *Caterpillar Tractor Co., Peoria 8, Ill.*

Care of Chains—A new 12-page bulletin contains tips on the care of chains, and a description of a line of field pumps. *Chain Belt Company, Milwaukee 4, Wis.*

Self-priming Pumps — A radically new approach to an old pumping problem is described in this bulletin about packingless, self-priming centrifugal pumps.—*The LaBour Co., Inc., Elkhart, Ind.*

Hydraulic Pumps—A bulletin tells of hydraulic pumps for industrial applications. The units are adaptable for special use on industrial tractors and trucks, power loaders and shovels, ditch diggers, earth moving machines, road machinery and various industrial machines and equipment.—*Pesco Products Co., 11610 Euclid Ave., Cleveland 6, Ohio.*

Pressure Distribution—A novel cut-out circular in the form of a nutshell tells the story of a pressure distributor that is said to apply tar, asphalt, cut-

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for

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Architects
Contractors

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You'll search a long time to find an instrument comparable to this Leupold product. Men who use it confirm our belief that all requirements are conveniently incorporated in this one accurate, moderately priced level.

Telescope is external focusing, 13 inches long, with 1¼ inch objective; achromatic lens with a flat field and magnification of 18 diameters . . . Horizontal circle for turning angles and two auxiliary standards to which the telescope may be shifted for plumbing vertical lines . . . Instrument weight—8 lbs. Tripod weight—7 lbs . . . Hardwood carrying case.

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back, road oils or emulsions with greater precision and efficiency than ordinary distributors.—*Littleford Bros., Inc., 453 East Pearl St., Cincinnati 2, Ohio.*

Roller Chain Belts—An 8-page folder on roller chain belts contains a table of specifications of the different sizes with their list prices. *Baldwin-Duckworth Division of The Chain Belt Co., Springfield 2, Mass.*

Beryllium—No longer under allocation, beryllium copper alloys are available promptly as ingots, shot or powders. They are also available as rods, strip, sheet and wire and in the form of castings and various shapes. Described in a folder are beryllium metal, and aluminum nickel and special alloys, as well as beryllium oxide as a high temperature refractory. *The Brush Beryllium Co., 3714 Chester Ave., Cleveland 14, Ohio.*

Stress-strain Diagrams—A bulletin contains design data, including an analysis of stress-strain diagrams. Other engineering applications indicating strength and toughness are also described.—*Meehanite Research Institute, 800 Pershing Square Building, New Rochelle, N. Y.*

Fiberglas—"Fiberglass . . . An Engineering Material" a 42-page report has been prepared to give information about this comparatively new material.—*Bureau of Industrial Service, Inc., 285 Madison Avenue, New York 17, N. Y.*

Industrial Flooring—A bulletin tells about non-slip floorings and deckings for use near machinery and on scaffolds, stair treads or walking areas.—*Miller Marine Decking, Inc., 230 Park Ave., New York 17, N. Y.*

Insulation Data Sheets—In these standard file sheets are to be found data on design and application of a wood fiber insulation in various types of construction.—*Wood Conversion Co., First National Bank Building, St. Paul, Minn.*

Industrial Tires—A booklet discusses how rubber industrial tires save on hauling time, floor wear, noise and depreciation, reduced breakage and accidents. There are suggestions on centering tires correctly on wheels, selecting the proper tire, allowing sufficient tire clearance, keeping runways clean, increasing carrying capacity, inspecting tires regularly, avoiding excessive heat area, lining inside travel routes to serve as guides, checking steering and axle alignment, lubricating regularly, avoiding overloads as well as acids, oils, gasoline and sharp turns and watching standing loads.—*The B. F. Goodrich Co., Akron, Ohio.*

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